A LOOK AT THE RENEWABLE ECONOMY IN RURAL AMERICA

HEARING

BEFORE THE

SUBCOMMITTEE ON COMMODITY EXCHANGES, ENERGY, AND CREDIT

OF THE

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SUBMITTED MATERIAL

A LOOK AT THE RENEWABLE ECONOMY IN RURAL AMERICA

TUESDAY, NOVEMBER 16, 2021

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON COMMODITY EXCHANGES, ENERGY, AND CREDIT,
COMMITTEE ON AGRICULTURE,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:01 a.m., in Room 1300 of the Longworth House Office Building and via Zoom, Hon. Antonio Delgado [Chairman of the Subcommittee] presiding.

Members present: Representatives Delgado, Plaskett, Khanna, Axne, Rush, Craig, Kuster, Bustos, Fischbach, Austin Scott of Georgia, LaMalfa, Davis, Jacobs, Balderson, Cloud, Feenstra, Cammack, Thompson (*ex officio*), Hartzler, and Baird.

Staff present: Emily German, Chu-Yuan Hwang, Luke Theriot, Paul Balzano, Josh Maxwell, Erin Wilson, and Dana Sandman.

OPENING STATEMENT OF HON. ANTONIO DELGADO, A REPRESENTATIVE IN CONGRESS FROM NEW YORK

The CHAIRMAN. This hearing of the Subcommittee on Commodity Exchanges, Energy, and Credit entitled, *A Look at the Renewable Economy in Rural America,* will come to order. Welcome, and thank you all for joining today's hearing. After brief opening remarks, Members will receive testimony from our witnesses today, and then the hearing will open to questions. Members will be recognized in order of seniority, alternating between Majority and Minority Members, and in order of arrival for those Members who have joined us after the hearing was called to order. When you are recognized, you will be asked to unmute your microphone, and will have 5 minutes to ask your questions or make a comment. If you are not speaking, I ask that you remain muted in order to minimize background noise. In order to get as many questions as possible, the timer will stay consistently visible on your screen.

In consultation with the Ranking Member and pursuant to Rule XI(e), I want to make Members of the Subcommittee aware that other Members of the full Committee may join us today.

Good morning, and thank you all for joining us today. We are here to talk about the renewable economy in rural America. From the agricultural commodities used to produce biofuels or biobased products to the land used for wind and solar projects and efficiency, increasing technologies like anaerobic digesters, rural communities are integral to the future of renewable energy. And as long as we

have the right policies and supports in place, these communities stand to benefit greatly.

Renewable technologies and processes continue to develop and improve. As they do, it is important that Congress ensure Federal programs and incentives are effective and impactful for rural communities transitioning to renewable energy. In today's hearing, we will hear about the latest developments in the renewable economy, challenges that need to be addressed, and how rural America can continue to benefit from its growth.

While creating more business and economic opportunities for rural areas, it is an important focus of today's hearing, we cannot forget that residential energy affordability is still a real problem in rural America. Inefficient and outdated energy infrastructure means more costly energy bills for rural residents. We have seen a slower transition to renewable energy, as it often proves too costly without outside support or incentives.

Our panel of witnesses will touch on all of these issues, the status of the biofuels and biobased product industry, and the financing, construction, and crafting of renewable energy projects that benefit rural communities.

While the focus of our hearing is on the benefits strategic investments in the renewable economy provide rural America, the growth of this industry stands to have a substantial impact on the national and global economy, with some experts estimating the direct economic impact of biobased products, services, and processes at up to $4 trillion per year globally over the next 10 years. Furthermore, the growth of the domestic renewable economy helps secure America's energy future, reducing our reliance on petroleum imports and making the best use of our domestic resources.

The topic of today's hearing is dynamic, multi-faceted, and timely, and as the House Agriculture Committee begins work on the next farm bill, the discussion we have here today will be informative to that process.

[The prepared statement of Mr. Delgado follows:]

PREPARED STATEMENT OF HON. ANTONIO DELGADO, A REPRESENTATIVE IN CONGRESS FROM NEW YORK

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The CHAIRMAN. With that, I would now like to welcome the distinguished Ranking Member, the gentlewoman from Minnesota, Mrs. Fischbach, for any opening remarks she would like to give.

OPENING STATEMENT OF HON. MICHELLE FISCHBACH, A REPRESENTATIVE IN CONGRESS FROM MINNESOTA

Mrs. FISCHBACH. Thank you, Mr. Chairman, and thank you for the opportunity, and good morning to everyone. I want to thank you all for taking the time to be here today.

Like many of my colleagues, I represent a rural ag-based district. We are among the top ag-producing districts in the nation, and we are responsible for nearly half of Minnesota's agricultural sales.

Minnesota and my district also play a key role in renewable energy. Minnesota farmers care deeply about the conversation and the environment, and are innovators in that area. Being the first state to implement E10 and the B20 mandates, my district is home to eight biofuel plants and we are the top producer in corn and soybeans that provide feedstocks for these plants.

Discussions of lower carbon emissions must include, and enhance, the use of biofuels. It is an existing proven fuel source, and must be part of that conversation.

Since taking office, I have spent a lot of time traveling across my district. I have met with local officials, business owners, farmers, families, and many others. One thing I can tell you is that rural America is facing many challenges right now—made all the more evident by COVID–19—challenges like limited access to capital, worker and skill shortages, aging infrastructure, limited access to broadband, and diminished access to healthcare services. We should be doing everything we can to help these ag economies thrive, and should be wary of taking actions that will create more challenges than opportunities.

I am a little concerned about some of the efforts the Majority has that don't recognize that biofuels have been an important part of the role in reducing our greenhouse emissions. Combines cannot run on electricity or wind or solar. There remains an important role for liquid fuels to play in our communities.

I would also like to have the conversation about bioproducts of agriculture commodities. I am glad to see panelists that can speak to the work they are doing to diversify the value-add of products coming from the farm as a vehicle for rural development. I am interested in learning more in that regard.

Taking care of our rural communities and ensuring that they have what they need to thrive benefits the ag economy, but it also benefits the rest of the country. If we can help meet those needs together, it is all of our constituents who will reap those benefits.

I join the Chairman in welcoming all of our witnesses, and we appreciate your time and I am looking forward to today's discussion.

Thank you, Mr. Chairman. I yield back.

The CHAIRMAN. Thank you, Ranking Member. I also would like to recognize Ranking Member Thompson for any opening comments he would like to make.

OPENING STATEMENT OF HON. GLENN THOMPSON, A REPRESENTATIVE IN CONGRESS FROM PENNSYLVANIA

Mr. THOMPSON. Thank you, Mr. Chairman and Ranking Member. I really appreciate you both, and thank you for convening today's hearing on rural America's renewable economy.

As you have heard me say before, without the producers in rural America, our cities would wake up in the cold, dark, and hungry.

With that being said, I would like to thank all of you here today for your role in powering rural America, and for sharing your perspective and testimony with us.

In Pennsylvania's 15th Congressional district, which I am proud and honored to represent, there is innovation at every turn. Whether that be biomass, renewable power sources, or critical mineral research, our universities and private institutions are contributing to significant progress within the renewable energy economy.

And, research is just as critical to help grow our new markets for biobased products of all kinds, including both energy and advanced materials. For example, the 2018 Farm Bill contains provisions that support research and development for cross-laminated timber and tall wood buildings. Developing materials like CLT provide forest owners new opportunities for renewable wood products and support rural communities, while generating forest health benefits in the process.

While I proudly support research and innovation, deployment of renewables, I must stress that the farmers, ranchers, and landowners in my district cannot supply the world's food and fiber without 24/7 access to reliable and affordable energy.

I must also address the current makeup of my state's renewable energy economy. The Energy Information Administration found that in 2020, renewable energy resources generated about four percent of Pennsylvania's electricity. As this number grows, I am committed to balancing the needs of the Commonwealth's families, communities, and producers who rely on natural gas-fired, coal-fired, and nuclear power generation with the needs of the innovators in the renewable economy that we are hearing from today.

With that, thank you, Mr. Chairman, and I look forward to today's discussion and yield back.

The CHAIRMAN. Thank you, Ranking Member Thompson.

The chair would request that other Members submit their opening statements for the record so witnesses may begin their testimony, and to ensure that there is ample time for questions.

To our witnesses, I am pleased to welcome such a distinguished panel of witnesses to our hearing today. Our witnesses bring to our hearing a wide range of experience and expertise, and I thank you all for joining us.

Our first witness today is Emily Skor, the Chief Executive Officer of Growth Energy, which represents over ½ of all U.S. ethanol production. Since joining Growth Energy, Ms. Skor has led initiatives to grow the retail presence of higher biofuel blends across the U.S. and launched Growth Energy's first consumer education initiative to redefine ethanol as a cleaner and more affordable fuel choice. Under her leadership, Growth Energy membership has grown to include 92 plant producers and 91 innovative businesses that support biofuel production. Welcome, Ms. Skor.

Our next witness today is Mr. Jeff Pratt, the President of Green Power EMC. Green Power EMC secures renewable energy resources for the broader family of 38 electric cooperatives in Georgia, which delivers power to approximately 4.3 million Georgians. In his role, Mr. Pratt leads efforts to source, evaluate, and contract for renewable energy projects. Today, Georgia's electric cooperatives have approximately 1,600 megawatts of renewable energy in operation or under construction. Mr. Pratt also serves as the Vice President of Emerging Technologies for Oglethorpe Power Corporation, where he leads collaborative efforts to explore, engage, and implement emerging technologies such as electric vehicles and other new technologies changing the energy landscape. Welcome, Mr. Pratt.

To introduce our third witness today, I am pleased to yield to our colleague on the Committee, the distinguished gentlewoman from Missouri, Mrs. Hartzler.

Mrs. HARTZLER. Oh, thank you, Mr. Chairman, and it is an honor to introduce Gary Wheeler. He is the Executive Director and CEO of the Missouri Soybean Association, the Missouri Soybean Merchandising Council, and the Foundation for Soy Innovation. Gary and I have worked together for years. He is a very respected leader in agriculture in our state, and I feel confident that he is going to bring us many very helpful insights as we look at renewables and the role that agriculture can play in it. So, I am proud to welcome Gary, and thank you for being here.

I yield back.

The CHAIRMAN. I thank the gentlewoman.

Our fourth witness is Ms. Jessica Bowman, who is the Executive Director of the Plant Based Products Council. The Plant Based Products Council represents a broad range of companies who support greater adoption of products and materials made from renewable plant-based inputs. Ms. Bowman leads the organizations efforts to advocate for the expanded use of renewable plant-based materials, including through collaboration with early-phase startups and Fortune 500 companies on their sustainability efforts and awareness initiatives. As an engineer and lawyer, Ms. Bowman plays a unique role in bridging the gap between today's biobased innovations and policies that encourage their broader adoption. Welcome, Ms. Bowman.

Now, I am incredibly pleased to introduce our next witness from my own district, Ms. Nan Stolzenburg, the Principal Consulting Planner of Community Planning & Environmental Associates, and a friend. Ms. Stolzenburg plays an important role in assisting small and rural communities in development of land use and environmental planning. Ms. Stolzenburg has a special interest in small

town and rural planning, community revitalization, comprehensive planning, land use regulations, and public participation. In her role, she has been the principal consultant in over 70 communities, and is 1 of 33 people nationwide to have received the Certified Environmental Planner advanced certification. Ms. Stolzenburg is also a member of my locally-based agriculture advisory committee. Welcome, Ms. Stolzenburg.

To introduce our sixth and final witness today, I am pleased to yield to the Ranking Member, the gentlewoman from Minnesota, Mrs. Fischbach.

Mrs. FISCHBACH. Thank you, Mr. Chairman.

It is my pleasure to introduce Randy Aberle, Executive Vice President of Agribusiness and Capital Markets for AgCountry Farm Credit Services, a financial cooperative that helps more than 200,000 business in North Dakota, Minnesota, and Wisconsin. Mr. Aberle is certainly an expert in the field. He received a Bachelor of Science degree in agricultural economics, and has worked with AgCountry for over a decade. I am so excited for everyone here to benefit from his experience and to hear more about how AgCountry has been involved in the renewable economy. Farm Credit is so important in rural America as an outlet for financing that might not otherwise be available, compared with cities where big banks are plentiful. I know that they have helped a lot of family farms and businesses in my district, like Kohls Land and Cattle in Hutchinson, and Matt and Erica Jensen's farm in Fergus Falls. It is important that we remember the real farmers and ag producers like them need to have a seat at the table in all proposed legislation and discussions, particularly as we begin work on the next farm bill. Welcome to the Committee.

Thank you. I yield back.

The CHAIRMAN. I thank the gentlewoman.

Welcome to all of our witnesses today. We will now proceed to hearing your testimony. You will each have 5 minutes. The timer should be visible to on your screen and will count down to 0, at which point your time has expired.

Ms. Skor, please begin when you are ready.

STATEMENT OF EMILY SKOR, CHIEF EXECUTIVE OFFICER, GROWTH ENERGY, WASHINGTON, D.C.

Ms. SKOR. Chairman Delgado, Ranking Member Fischbach, and Members of the Subcommittee, thank you for the opportunity to testify today on the role of renewable energy in the rural economy. I am Emily Skor, CEO of Growth Energy, the nation's largest ethanol trade association, representing plant producers and their innovative business partners.

Ethanol production has long been an economic driver for our rural economies. The United States is home to 210 biorefineries across 27 states that have the capacity to produce more than 17 billion gallons of low-carbon renewable fuel. Our industry is the second largest customer for U.S. corn growers, and will purchase nearly $30 billion worth of corn this year to produce ethanol and an expanding array of biobased products, such as high protein animal feed, renewable chemicals, and corn oil.

Renewable fuels like ethanol remain the single-most affordable and abundant source of low-carbon motor fuel on the planet, and are critical to meeting carbon reduction goals today. Recent research shows there is no path to net-zero emissions without biofuels. Even accounting for the projected growth of electric vehicles, the Energy Information Administration indicates that the vast majority of cars on the road through 2050 will run on liquid fuels. Higher blends of ethanol can be used in our current auto fleet to accelerate our transition to a 100 percent renewable energy future. Put simply, America cannot de-carbonize the transportation sector without homegrown biofuels.

To meet the rising demands for renewable energy, we must first have a strong and thriving rural economy and biofuel industry. At a minimum, that means the Biden Administration and Congress must ensure that biofuels are part of our transportation mix now and into the future. This can be achieved through a strong Renewable Fuel Standard, accelerated nationwide use of higher blends like E15, accurate carbon modeling of ethanol to better reflect the most current data, sustainable farming innovations, and carbon intensity reductions at our biorefineries, and incentives that provide producers with strong policy signals to further reduce our carbon intensity, and expand to new transportation markets.

A strong RFS will reduce carbon emissions and provide a steady market for U.S. grain. The annual blending requirements are woefully delayed, and in recent weeks, unsettling media reports indicate the EPA may turn its back on greater biofuel blending. It is critical for ethanol producers and suppliers that EPA immediately propose 15 billion gallons of conventional biofuels for 2021 and 2022. The Biden Administration simply cannot meet its climate goals while rolling back low-carbon biofuel blending requirements. We ask that the Subcommittee help deliver this message to the Administration.

We appreciate the Committee including nearly $1 billion in the Build Back Better Act (Pub. L. 117–169) to provide drivers access to more low-carbon, higher ethanol blends. This provision builds upon USDA's successful biofuel infrastructure programs under the last two Administrations. This investment complements a nationwide move to a 15 percent ethanol blend, which would meaningfully reduce greenhouse gas emissions, the equivalent of removing nearly four million vehicles from the road each year. It would also create more than 182,000 additional jobs, and save consumers $12.2 billion in fuel costs annually. To help realize these benefits, Congress must pass the Year-Round Fuel Choice Act of 2021 (H.R. 4410) from Representative Angie Craig to restore E15 summer sales.

Through continued innovation, America's ethanol producers and farmers are using fewer inputs and improving efficiencies at the plant and on the farm. We are pleased to see voluntary initiatives in the Build Back Better Act that would help further reduce the carbon intensity of agriculture, which accounts for 50 to 65 percent of our lifecycle emissions. As biofuel producers capture the value of low-carbon farming practices, farmers would also have the opportunity to benefit in the form of premium prices for their commodities. The legislation also contains several important incentives to

help ethanol producers further reduce the carbon intensity of their fuel, and explore new markets. These provisions, along with some recommended changes, are detailed in my written testimony.

To close, with the right policy environment, our industry can continue to de-carbonize our transportation sector from passenger vehicles to our aviation fleet. We stand with rural America, ready to assist Congress and the Administration to achieve our nation's climate goals.

Thank you for the opportunity to testify. I look forward to your questions.

[The prepared statement of Ms. Skor follows:]

PREPARED STATEMENT OF EMILY SKOR, CHIEF EXECUTIVE OFFICER, GROWTH ENERGY, WASHINGTON, D.C.

Chairman Delgado, Ranking Member Fischbach, and Members of the Subcommittee:

Thank you for the opportunity to testify today on the role biofuels like ethanol play in the renewable economy in rural America. My name is Emily Skor, and I am the CEO of Growth Energy, the world's largest ethanol trade association.

Growth Energy represents over ½ of all U.S. ethanol production, including 92 producer plants, 91 innovative businesses that support biofuels production, and tens of thousands of ethanol supporters around the country.

Ethanol production has long been an economic driver for our rural economies. The United States is home to 210 biorefineries across 27 states that have the capacity to produce more than 17 billion gallons of low-carbon, renewable fuel.

Ethanol is also the second-largest customer to 300,000 U.S. corn growers with roughly ⅓ of the field corn crop used to produce fuel ethanol each year.[1] In a particularly unusual year of depressed demand in 2020, the ethanol industry purchased 4.78 billion bushels of corn to produce nearly 14 billion gallons of biofuels and more than 36.4 million tons of dried distillers grains.[2] Also in 2020, 26.6% of field corn went into fuel ethanol.[3] This year, our industry will purchase nearly $30 billion of corn to produce ethanol and co-products such as high-protein animal feed and corn oil.

Renewable fuels like ethanol remain the single most affordable and abundant source of low-carbon motor fuel on the planet—and are critical to meeting carbon reduction goals today.

Recent research shows there is no path to net-zero emissions by 2050 without biofuels. Even accounting for the projected growth of electric vehicles, the Energy Information Administration indicates that the vast majority of cars on the road through 2050 will run on liquid fuels. Biofuels like ethanol are affordable, available, and can be used in our current auto fleet. Put simply, America cannot de-carbonize the transportation sector without homegrown biofuels.

My comments today will focus on how America's ethanol industry is leading the way in producing renewable energy in our rural areas, driving new economic activity and environmental benefits. Specifically, I will explore the following areas:

- Why low-carbon liquid biofuels like ethanol are essential to meet our climate goals;
- How programs at the U.S. Department of Agriculture and provisions in the Build Back Better Act can help us further de-carbonize transportation;
- How a strong and growing RFS will continue to cut carbon emissions from transportation; and
- How higher-level ethanol blends like E15 can drive down emissions and lower consumer fuel costs.

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[1] National Corn Growers Association. *https://www.ncga.com/key-issues/current-priorities/ethanol*.

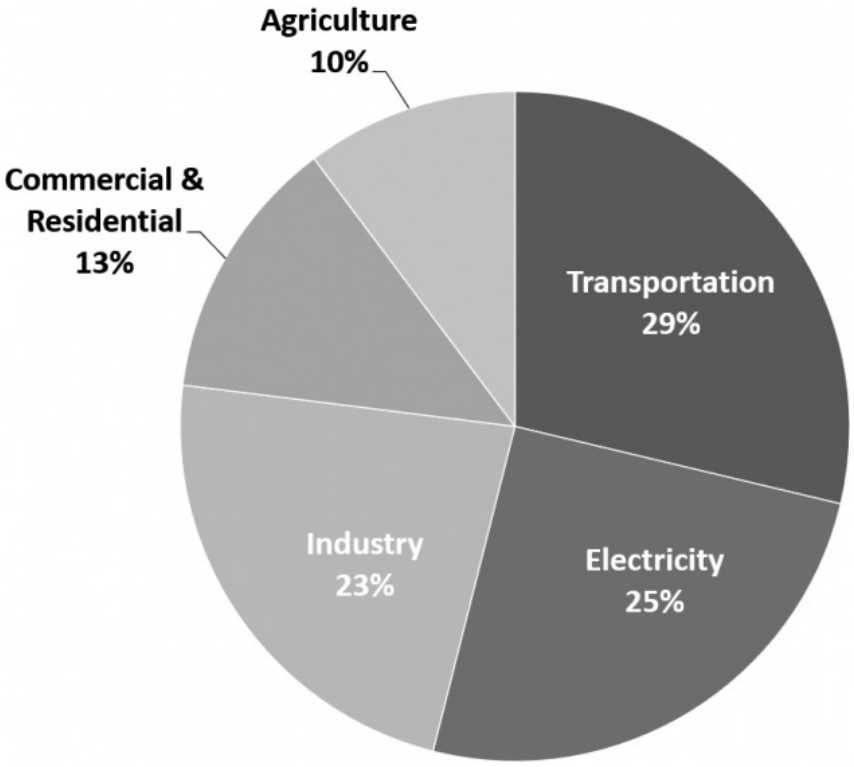
[2] "Grain Crushings and Co-Products Production—2020 Summary," U.S. Department of Agriculture. March 2021. *https://downloads.usda.library.cornell.edu/usda-esmis/files/v979v304g/jh344m06h/1j92h279h/cagcan21.pdf*.

[3] "Corn Usage by Segment 2020," National Corn Growers Association. April 2021. *https://www.worldofcorn.com/#corn-usage-by-segment*.

Biofuels: An Essential Solution to Meet Climate Goals

Figure 1: U.S. GHG Emissions by Sector

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2019



Source: EPA.

This past year has seen an increased focus on achieving long-term carbon reduction goals. The Biden Administration has pledged to reduce greenhouse gas (GHG) emissions by 50–52% by 2030 and make the United States carbon neutral by 2050. There is no one-size-fits-all path toward de-carbonization. Meeting this challenge will require a broad array of solutions and renewable biofuels like ethanol are readily available today to accelerate our transition to a healthier, net-zero emission, 100% renewable energy future.

In 2019, the transportation sector accounted for 29% of all greenhouse gas emissions in the United States, the highest of any major economic sector.[4] Lowering carbon emissions in transportation is paramount to meet the Biden Administration goals. Biofuels can immediately lower GHG emissions and help de-carbonize the transportation sector.

Plant-based ethanol is low-carbon and can be used in our current auto fleet. It is also affordable, keeping fuel prices lower for all drivers in all communities. Drivers today can choose fuel blended with ten percent ethanol (E10), fifteen percent ethanol (E15), or up to eighty five percent ethanol (E85).

A recent January 2021 study by Environmental Health and Engineering, Inc. found that ethanol reduces GHGs by 46% compared to traditional gasoline.[5] The use of biofuels from 2008 to 2020 has already resulted in cumulative reductions of al-

[4] "Sources of Greenhouse Gas Emissions," U.S. Environmental Protection Agency. *https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions*.

[5] "Carbon Intensity of corn ethanol in the United States: State of the science," Environmental Health & Engineering, Inc. Melissa Scully, Gregory Norris, Tania Alarcon Falconi, and David MacIntosh (March 2021). *https://iopscience.iop.org/article/10.1088/1748-9326/abde08*.

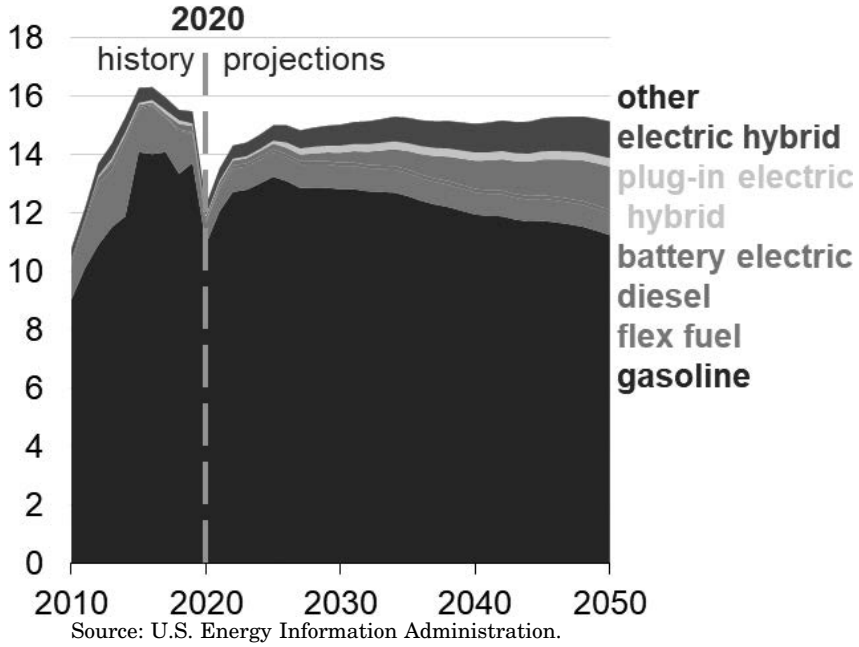
most 1 billion metric tons of carbon dioxide-equivalent GHG emissions.[6] Additionally, a study by Growth Energy showed that nationwide transition from E10 to E15 would lower GHG emissions by 17.62 million tons annually, the equivalent of removing 3.85 million vehicles from the road.[7]

Recent data from the U.S. Energy Information Administration (EIA) indicates that while we will see dramatic growth in the number of electric vehicles, vehicles that run on liquid fuels will dominate the light duty transportation landscape for decades. EIA's Annual Energy Outlook from 2021 stated that gasoline and flex fuel vehicles will account for 79% of vehicles sales in 2050, down from 95% today, as referenced in *Figure 2*.[8] Moreover, EIA projects in its 2021 International Energy Outlook that, worldwide, the number of conventional light-duty vehicles—those which operate on liquid fuels—will not peak until 2038.[9]

Figure 2: Light-duty Vehicle Sales by Fuel Type

Light-Duty Vehicle Sales by Technology/Fuel AEO2021 Reference Case

Millions of Vehicles



Source: U.S. Energy Information Administration.

To meet these challenges, we cannot rely on a single solution to propel our transportation sector to net-zero carbon emissions by 2050. We will need every tool in our toolbox. We will see increased efforts towards electrification and vehicle efficiency, but we will also need more biofuels like ethanol, which have the potential to do even more to reduce the carbon intensity of transportation with the right combination of policy and marketplace certainty. An analysis by the Rhodium Group released in January 2021 found that biofuels are a mainstay for any climate strategy looking to attain net-zero emissions by 2050.[10]

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[6] "GHG Emissions Reductions due to the RFS2—A 2020 Update." Life Cycle Associates, Unnasch, Stefan and Debasish, Parida. February 2021. *https://ethanolrfa.org/file/748/LCA_-_RFS2-GHG-Update_2020.pdf*.

[7] "GHG Benefits of 15% Ethanol (E15) Use in the United States," Air Improvement Resources, Inc. *http://www.airimprovement.com/reports/national-e15-analysis-final.pdf*.

[8] "Annual Energy Outlook 2021," Energy Information Administration. *https://www.eia.gov/outlooks/aeo/pdf/AEO_Narrative_2021.pdf*.

[9] "EIA projects global conventional vehicle fleet will peak in 2038," Energy Information Administration. *https://www.eia.gov/todayinenergy/detail.php?id=50096&src=email*.

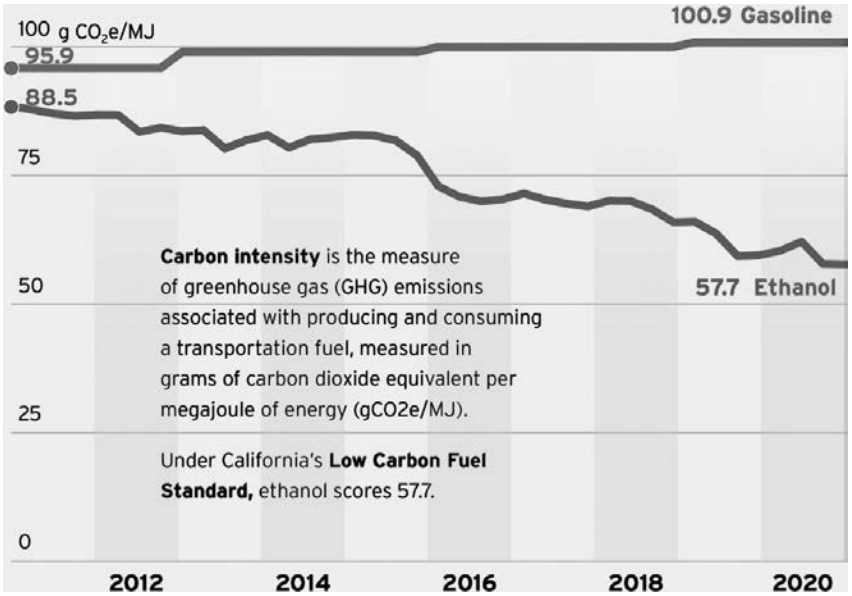
[10] "Closing the Transportation Emissions Gap with Clean Fuels," Rhodium Group. *https://rhg.com/research/closing-the-transportation-emissions-gap-with-clean-fuels/*.

One of the most compelling demonstrations of the essential role biofuels play in meeting climate goals is California's Low Carbon Fuel Standard (LCFS). The goal of the LCFS is to, "encourage the use of cleaner low-carbon transportation fuels in California, encourage the production of those fuels, and therefore, reduce GHG emissions and decrease petroleum dependence in the transportation sector." [11]

According to data by the California Air Resources Board (CARB), biofuels are responsible for nearly 80% of all carbon reductions credited under the LCFS, with the recorded carbon intensity (CI) of ethanol declining 33% since 2011.[12]

CARB tracks the CI of a variety of fuel options and has updated the CI scores annually since the state's LCFS was adopted in January 2011. *Figure 3* shows the steady decline in the CI score for ethanol and the uptick in CI score for gasoline over the same period.

Figure 3: CARB's Carbon Intensity Scores of Ethanol and Gasoline



Source: California Air Resources Board.

Improvements in ethanol's CI scores can be attributed to the biofuel industry's increased manufacturing efficiency through less energy intensive energy usage, more effective biotechnology, lower water usage and increased efficiencies in the amount of land used for biofuel feedstock production. America's corn growers are producing stronger yields with less acreage, and biorefineries can manufacture more gallons of ethanol per bushel of corn. Total cropland acreage has fallen from 470.8 million acres in 1978 to 391.9 million acres in 2012.[13] Moreover, yields of corn have increased dramatically over the last 50 years, increasing from 72.4 bushels per acre in 1970 to 172 bushels per acre in 2020. Over the last 10 years, corn yield has increased by 20%,[14] while land planted for corn has remained steady. *Figure 4* demonstrates the improvements in corn yields over the last 150 years.

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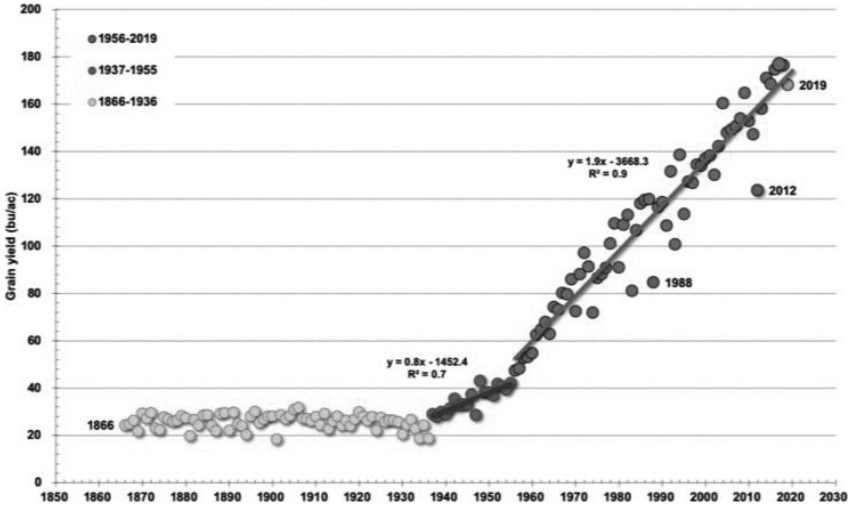
[11] California Air Resources Board. Accessed 6/15/2021, *https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/about*.

[12] "Data Dashboard: Low Carbon Fuel Standard," California Air Resources Board. May 2020, *https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm*.

[13] "Cropland, 1945–2012, by State: The sum of cropland used for crops, cropland idled, and cropland used for pasture," U.S. Department of Agriculture's Economic Research Service. August 2017, *https://www.ers.usda.gov/data-products/major-land-uses/*.

[14] "Crop Production Historical Track Records," National Agricultural Statistics Service. April 2021, *https://www.nass.usda.gov/Publications/Todays_Reports/reports/croptr21.pdf*.

Figure 4: Corn Crop Yields 1866–2019



Data Source: USDA–NASS (as of Jan. 2020).

Source: USDA–NASS and Historical Corn Grain Yields in the U.S. (Purdue University)*

USDA: A Department Well Positioned to Help De-carbonize Transportation

USDA's 2015 Biofuel Infrastructure Partnership (BIP) and the 2020 Higher Blends Infrastructure Incentive Program (HBIIP) are prime examples how the Department can support the productivity of our farmers and boost rural economies while decreasing GHG emissions. With the $1 billion of funding included in the Build Back Better (BBB) Act to expand the availability of biofuels, we stand ready to work with the Department to put this funding to work to further de-carbonize the cars on the road today.

Currently, more than 95% of cars on the road are compatible with E15,[15] and consumers have driven more than 25 billion miles on the fuel. There is a significant market available today for higher blends of biofuels like E15 if consumers can access these products. The biofuels industry is ready to provide the fuel necessary to meet those demands; however, long-term infrastructure incentives for our retailers, like the competitive grant structure under BIP and HBIIP, must be available.

Demand for these grants exceeded funds available, demonstrating that retailers and the working families they serve want a lower cost fuel and more choices at the pump. This gives retailers a competitive advantage in the market while providing our transportation sector a higher quality fuel that decreases GHG emissions.

Build Back Better with Biofuels

The BBB Act currently before Congress includes important infrastructure funding to encourage the adoption and availability of higher-level biofuel blends through the Biofuel Infrastructure and Agriculture Product Market Expansion provision included in the bill. This important funding is a key component of a suite of authorities included in the BBB that provide concrete incentives to lower the carbon intensity of transportation fuel.

The Biofuel Infrastructure and Agriculture Product Market Expansion program provides $960 million in funding through September 30, 2031, to install, retrofit, or otherwise upgrade fuel dispensers or pumps and related equipment, storage tank system components, and other infrastructure required at a location to dispense ethanol blends above 10% and biodiesel blends above 5%. Funds may also be used to build and retrofit distribution systems for ethanol blends, traditional and pipeline biodiesel terminal operations (including rail lines), and home heating oil distribution

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* *https://www.agry.purdue.edu/ext/corn/news/timeless/YieldTrends.html*.

[15] Air Improvement Resources, Inc. "Analysis of Ethanol Compatible Fleet for Calendar Year 2021," November 9, 2020. *https://growthenergy.org/wp-content/uploads/2020/11/Analysis-of-Ethanol-Compatible-Fleet-for-Calendar-Year-2021-Final.pdf*.

centers or equivalent entities to blend biodiesel and to carry ethanol and biodiesel. This provision authorizes a maximum Federal share of a project would be 75%, up from 50% under the most recent USDA program from 2020. And importantly, the provision allows USDA to provide sizeable grant packages to market participants that sell high volumes of fuel, allowing the program to secure more carbon reductions at a lower cost.

Biofuel Infrastructure and Agriculture Product Market Expansion Program Recommendations

Having worked very closely alongside retailers for both BIP and HBIIP to secure grant funding, and having administered the industry's more than $90 million private matching grant program, Prime the Pump, we have three different recommended approaches we encourage the House Agriculture Committee and USDA to consider for the next round of infrastructure incentives for higher blends should the BBB be passed into law:

1. **Use an equipment-focused approach and allow all fuel dispensing and underground storage equipment upgrades to be eligible under a future grant program.**

   Historically, BIP and HBIIP have focused on dispenser replacement and underground storage tanks. However, there are more than 100 pieces of equipment needed to legally dispense fuels, so the cost per site can vary widely based on retailer needs. Based on historical sales data provided by retailers, assuming a $960 million grant program, this program would generate about 8 billion gallons of E15 sales. The program should also require that E15 is sold on a shared hose with other grades of fuel to make consumer access as easy as possible.

2. **Provide a sales incentive for retailers offering E15.**

   Industry research by the National Association of Convenience Stores [16] found that consumers will drive 5 miles out of their way to save $0.05 per gallon. By providing a $0.05 per gallon of E15 incentive, a $960 million grant program has the potential to yield nearly 18 billion gallons of E15 sales. Offering retailers a performance incentive, along with small bonus payments for installation targets, has been the optimal method for Prime the Pump.

3. **Increase funding for large volume retailers and streamline the paperwork required by a retailer.**

   We are pleased to see that the language included in the BBB Act that allows for additional funds for large-volume retailers. Some larger retail chains will want to upgrade hundreds of stores to provide universal access to E15 and higher blends across their entire market chain, increasing the availability of low-carbon liquid fuels. For small retailers, reducing the amount of paperwork will help them access infrastructure grants. Lastly, we recommend that any future grant programs allow companies which aggregate fuel for several small retailers be eligible to participate in the program as well.

In the end, flexibility is the most important element of the next infrastructure program. Focusing the grants solely on dispensers and tanks, disincentivizing large volume retail locations, or issuing too many burdensome administrative hurdles limits its overall access to the program. We encourage the Subcommittee and USDA to leverage learnings from previous public and private grant programs. Growth Energy will lend our expertise to help in any way we can to ensure a future program is another success.

Build Back Better Provides Voluntary Incentives to Lower Carbon Farming

America's biorefineries have deployed a number of low-carbon practices to reduce the carbon intensity of our fuel, including wind energy, solar energy, carbon capture, combined heat and power, and more. In fact, almost all capital expenditures at ethanol biorefineries today are aimed at reducing their carbon footprint to take advantage of low-carbon fuel markets like those in the western United States and abroad.

Even with significant innovation at our member's plants, farming practices still account for roughly 50–65% of the lifecycle carbon emissions of these fuels. Farmers have already responded to the call for improved sustainability, using fewer inputs and increasing efficiencies in their farming practices. These improved practices have already helped reduce the CI of farming, and therefore the overall carbon intensity of biofuels.

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[16] National Association of Convenience Stores. "2015 Retail Fuels Report," Page 12. *https://www.convenience.org/*.

The BBB Act provides further voluntary incentives like cover crops, nutrient management, buffers, and incentives for locally led conservation efforts that will help reduce the CI of agriculture even further, helping biofuel producers provide an even lower carbon liquid fuel at a time when demand for low-carbon fuels is rising. As biofuel producers benefit from low-carbon farming practices, farmers also benefit in the form of premium prices for their commodities.

States like California, Oregon, and Washington are all placing an emphasis on incorporating more carbon-friendly fuel into their transportation supply through Low Carbon Fuel Standard and Clean Fuel Standard (CFS) programs in the states. The LCFS places a premium on fuel sources which have lower CI scores to act as an incentive to fuel producers. Biofuels continue to provide the foundation towards reaching goals set in both California's LCFS and Oregon's CFS, but the American farm economy could further benefit with improved modeling.

For example, the LCFS does not currently account for low-carbon farming practices when rating the CI for various biofuels. Using less fertilizer through precision agriculture technologies lowers nitrogen use and would improve ethanol's CI score. Further improvements also include adopting farming techniques like no-till and planting cover crops keep nutrients in soil. The CI score can also be lowered significantly through the use of updated modeling that accurately reflects the carbon sequestered with the planting of corn, a natural carbon sink. Accounting for the CI benefits brought by these techniques and more would provide a greater premium for ethanol producers and the farmers they support.

How the Build Back Better Act Will Encourage More Low-Carbon Biofuels

Besides the important funding for infrastructure and voluntary farming incentives, the BBB Act contains several important incentives that will help ethanol producers further reduce the CI of their fuels and explore new markets outside of light-duty vehicles. We appreciate and support the inclusion of the following items:

1. **The extension and increase of the 45Q tax incentive for the capture, utilization, and storage of carbon dioxide.**

   Roughly half of our member plants either capture carbon for food and beverage use, expect to transport carbon dioxide by a carbon pipeline for permanent geologic storage, or expect to store carbon nearby for geologic storage. With 99.9% pure, clean fermentation carbon from an ethanol plant being relatively easy to capture, our facilities provide a good opportunity to deploy carbon capture technology and appreciably lower emissions. For the average U.S. ethanol plant, carbon capture can cut the CI in half.

2. **The establishment of the Clean Fuel Production Credit (CFPC, or 45CC), which provides an incentive to produce low-carbon biofuels.**

   This credit provides a producer-based tax incentive to encourage the adoption and deployment of low-carbon fuel technologies. The size of the incentive is based on the percentage of carbon reduction relative to a fixed baseline, reorienting our biofuels tax policy toward carbon reductions instead of producing specific types of fuel.

3. **A credit for the blending and production of sustainable aviation fuel (SAF).**

4. **The BBB Act establishes a standalone credit for SAF from 2022–26 and folds the SAF credit into the CFPC for 2027–31.**

   If properly implemented, these SAF incentives could provide a new marketplace for ethanol.

We would also like to provide the Committee with a list of suggested changes that would make the three provisions above work better and further reduce carbon in the transportation sector:

1. **A facility cannot claim CFPC (including SAF) and 45Q at the same time in last 5 years, while they can claim the initial standalone SAF credit and 45Q for first 5 years.**

   Because SAF will need an additional incentive to ensure parity with petroleum-based jet fuel, we believe that allowing an ethanol producer to claim both credits will have the maximum carbon reduction benefit and will continue to drive innovation in our industry.

2. **The CFPC does not start until 2027, leaving ethanol producers without a de-carbonization incentive between 2022 and 2027.**

   We recommend allowing low-carbon fuel facilities the option to elect to start the CFPC in 2022 to further accelerate emissions reductions.

3. **The positive 45Q changes only impact projects that commence construction after January 1, 2022.**

   We would encourage these changes to apply to all projects, allowing forward-thinking facilities that have already begun efforts to innovate to capture this benefit.

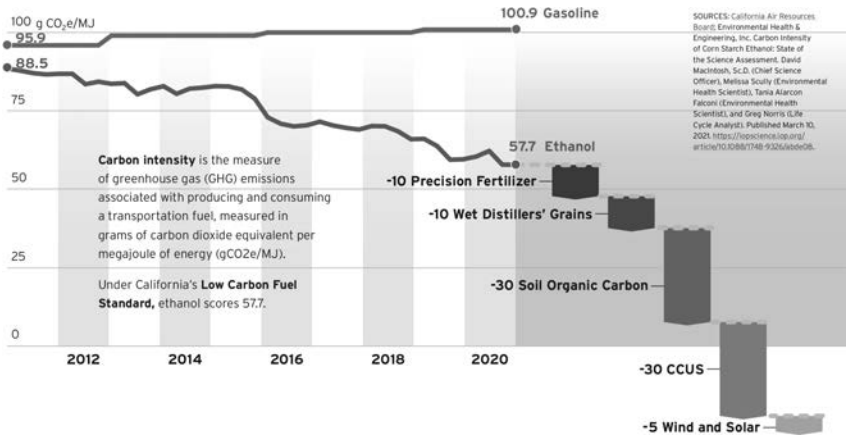
4. **Despite improvements, the SAF modeling language is still confusing and is now bifurcated after 2027 between non-aviation fuels, which use the Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) Model by the Argonne National Laboratory, and SAF, which has limited specification for a life cycle analysis model.**

   We recommend adopting the GREET model for all biofuels—including SAF—from the date of enactment moving forward. The Department of Energy's Argonne National Laboratory is a world leader in lifecycle analysis of biofuels, and it only makes sense to adopt their latest analysis, which is updated annually. It is important that new tax incentives are guided by technology-neutral life-cycle assessments by scientists who understand the U.S. biofuel sector. U.S. tax credits must reflect U.S.-based modeling.

   Our industry is committed to growing more clean energy jobs and the incentives in this legislation would provide that opportunity. We would encourage Congressional leaders to provide more detailed information on how our common goal of growth in clean-energy jobs can be met with the prevailing wage and apprenticeship requirements in the legislation.

Figure 5: Achieving Net-Zero Ethanol

Carbon Intensity of Ethanol Continues To Approach Net-Zero



Source: California Air Resources Board and Environmental Health and Engineering.

Biorefineries are researching and implementing technological improvements to further reduce the carbon intensity of ethanol. Using the California Air Resources Board data on the carbon intensity of ethanol as shown in *Figure 5* above, biorefineries can reach net-zero ethanol and even achieve negative carbon emissions using today's technology. Some examples include installing more renewable sources of energy including wind and solar and installing carbon capture and sequestration equipment.

Sustainable farming practices can also have an impact on reducing a biorefinery's carbon intensity score. Precision fertilizer and accurately accounting for the carbon sequestered with the planting of corn are other examples of methods to further reduce the carbon intensity.

A Strong and Growing RFS Will Continue to Cut Carbon Emissions from Transportation

The Renewable Fuel Standard (RFS) is one of the nation's most successful renewable energy policies in reducing GHGs and providing a steady market for U.S. grain. This policy is the bedrock for the modern biofuels industry, providing a stable policy

platform for ethanol producers to grow, expanding our nation's supply of renewable, low-carbon liquid fuels. Given the importance of this policy, we are greatly concerned about media reports that the Biden Administration is considering cutting the RFS, a position we believe directly contradicts President Biden's strong commitment to biofuels as a way to help rural economies and lower carbon emissions and only leaves us further reliant on fossil fuels.

Biofuels have long been an economic driver for our rural economies. In addition to the key jobs statistics cited at the outset of this testimony, it is important to note that biorefineries employ a skilled workforce in small, rural communities and are often the epicenter of the local economy. Accordingly, we have a strong interest in the future success of American agriculture.

Rural communities are eager to lead this charge, and the benefits to our economy are significant, especially as the cost of oil surges. Ethanol saves the average household $142 per year—an average of 22¢ per gallon—and even more with higher blends of ethanol. With this homegrown energy comes homegrown jobs, from farmers to the union professionals. As Daniel Duncan, Executive Secretary-Treasurer of the Maritime Trades Department (MTD), AFL–CIO, said just last week, "[u]nion members are not just on the production side of the American biofuel industry, but also build, operate, and maintain the infrastructure that keeps homegrown fuels like ethanol and biodiesel flowing. This sector is an important source of strength for union jobs, especially when it comes to growth in agricultural regions of the nation." [17]

Figure 6: Contribution of Ethanol Production to Individual State Economies, 2019

	Production (Mil Gal)	Production Share	GDP (Mil $)	Employment Jobs	Income (Mil $)
IA	4,126	26.0%	$9,096	82,294	$4,910
NE	2,176	13.7%	$4,797	43,401	$2,589
IL	1,833	11.5%	$4,041	36,560	$2,181
MN	1,315	8.3%	$2,900	26,232	$1,565
IN	1,083	6.8%	$2,388	21,601	$1,289
SD	1,002	6.3%	$2,209	19,985	$1,192
WI	648	4.1%	$1,429	12,924	$771
ND	487	3.1%	$1,074	9,713	$579
KS	518	3.3%	$1,142	10,332	$616
OH	408	2.6%	$900	8,138	$485
TX	335	2.1%	$739	6,682	$399
MI	283	1.8%	$624	5,644	$337
TN	230	1.4%	$507	4,587	$274
MO	165	1.0%	$364	3,291	$196
NY	165	1.0%	$364	3,291	$196
CA	158	1.0%	$348	3,151	$188
CO	125	0.8%	$276	2,493	$149
GA	120	0.8%	$265	2,393	$143
PA	110	0.7%	$243	2,194	$131

*Excludes construction, exports and R&D.

Source: ABF Economics.

In a February 2020 study, ABF Economics broke down the economic impact ethanol production brought to each state in 2019 which is shown in *Figure 6.*[18] The RFS is the policy that supports all this good work in building out clean-energy jobs in our rural areas and supporting the U.S. farm economy. We ask that the Members of this Subcommittee work with the Environmental Protection Agency (EPA) in ensuring the agency releases growth-oriented Renewable Volume Obligations (RVOs), the annual requirement for renewable fuel blending. In a first test of upholding his campaign promises, it has been reported that President Biden's EPA will reach back 2 years and retroactively lower RVOs for 2020 and also propose flat RVOs for 2021 with no market-forcing considerations.

[17] Seafarers International Union. "Biofuel Industry Boosts Union Jobs." November 10, 2021. *https://www.seafarers.org/biofuel-industry-boosts-union-jobs/*.

[18] "Contribution of the Ethanol Industry to the Economy of the United States in 2019," Urbanchuk, John M., Managing Partner. February 4, 2020. *https://files.constantcontact.com/a8800d13601/9e769376-3aef-4699-b31f-3c6415b8fa63.pdf*.

We are especially concerned about EPA reopening the 2020 RVOs retroactively and acceding to requests by oil states and refineries to lower 2020 RVOs for reasons unrelated to RFS compliance. The Biden Administration simply cannot meet its climate goals while retroactively rolling back low-carbon biofuel blending requirements even further to help oil refiners, in particular, when the hardship they claim resulting from the COVID crisis has been widely shared across a number of economic sectors. In addition, this would be an unprecedented move that not only exceeds EPA's legal authority under the RFS, but also would fail to recognize the RFS' built-in mechanism, via the annual RVO percentage standard, that already accounts for any changes in fuel demand that differ from original projections. When COVID decreased fuel demand in 2020, the RFS percentage standard decreased the requirement for conventional biofuels by at least 1.6 billion gallons, a more than 10% decrease. There is no need for further decreases.

We are also awaiting the RVOs for 2022, which will establish a foundation for RVOs over the next few years as EPA begins the Set rulemaking process to establish renewable fuel volumes for 2023 and beyond. It is critically important that EPA propose 15 billion gallons of implied conventional biofuels for 2022 so that the ethanol industry has a solid foothold in producing adequate supply in for years to come.

We urge you to continue to coordinate with EPA on proposing strong RVOs for 2021 and 2022 and release those values as soon as possible. We strongly oppose further delay and uncertainty with the RVOs—similar to what we saw in 2014 and 2015—and in particular, the loss of a binding, strong requirement for 2022. Continued delay creates uncertainty in the marketplace and has profound implications on the RFS set and the future of the program. The 2022 RVO, for example, will set the ratio of total vs. advanced renewable fuel volumes for 2023 RVOs and beyond. If EPA sets the 2022 RVO below 15 billion gallons of conventional biofuels—or does not set it at all—this could negatively impact renewable fuel blending for years to come.

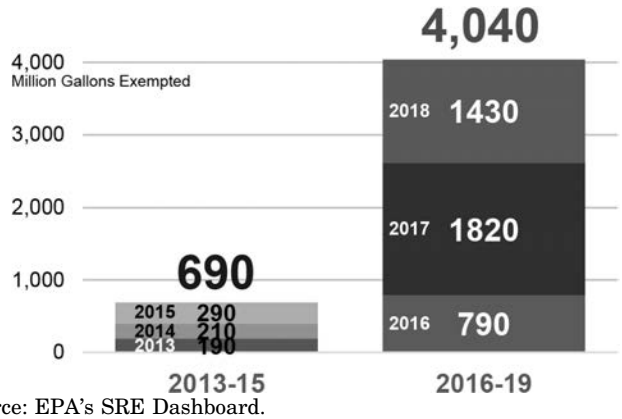
Small Refinery Exemptions

Despite the demonstrable economic, environmental, and energy security success of the RFS, the Trump Administration repeatedly granted oil refiners an unprecedented number of small refinery exemptions (SREs), allowing them to avoid their obligations to blend biofuels into our national fuel supply. Many on this Subcommittee advocated on behalf of biofuel producers in your districts to the Trump Administration against this radical escalation of exemptions, and we thank you for those efforts.

The SRE authority was included under the Clean Air Act to provide small refineries (those with a daily input capacity of less than 75,000 barrels of crude oil) with a temporary avenue to avoid blending obligations, provided the refinery demonstrate that compliance results in severe economic hardship. But in the previous Administration, the number of SREs increased six-fold with no transparency into the process or explanation as to which refineries received an exemption and why.

As shown in *Figure 7,* EPA granted 88 SREs over 4 years, which cost the industry 4.3 billion gallons of lost biofuel demand. Many of the SREs went to some of the largest, most profitable oil companies in the world.

Figure 7: SREs by Administration



Source: EPA's SRE Dashboard.

In January 2020, the 10th Circuit Court of Appeals issued a unanimous decision that invalidated SREs granted by EPA to three refineries for the 2016 and 2017 compliance years on three grounds. First, the court held that EPA could grant SRE "extensions" only to those refineries who had received SREs in all prior years. Second, the court held that it was improper for EPA to find disproportionate economic hardship on bases other than alleged hardship caused solely by compliance with the RFS. Third, the court held that EPA failed to explain why it deviated from its previous position that refineries recoup their costs of compliance through downstream pricing. The refineries petitioned the U.S. Supreme Court for review of the decision solely on the first, "extension" holding of the 10th Circuit, and the case was argued before the Court on April 27, 2021. On June 25, 2021, the Supreme Court overturned the "extension" portion of the 10th Circuit opinion.

Under the Biden Administration, EPA has stated that it agrees with the remainder of the 10th Circuit Court's opinion, in particular, that SREs must be based solely on hardship caused by compliance with the RFS.

We strongly urge the Biden Administration to uphold the integrity of the RFS program by encouraging more renewable, low-carbon fuel blending, narrowing the use of SREs in line with the decision in the 10th Circuit Court of Appeals, and set conventional blending requirements of at least 15 billion gallons.

RIN Prices

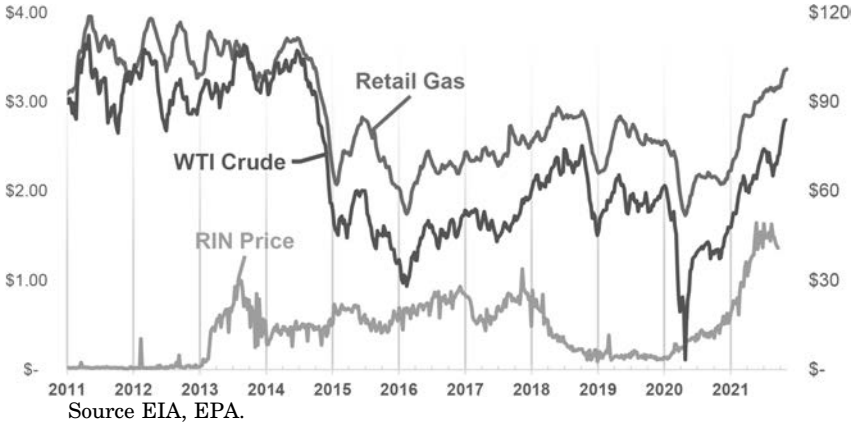
Renewable Identification Numbers (RINs) were included in the RFS to add flexibility to the compliance mechanism of the RFS. Obligated parties have the option to either blend biofuels and generate RINs or purchase RINs to meet their obligations under the RFS.

We are aware that some refiners that have chosen to purchase RINS in lieu of blending renewable fuels are seeking a waiver for their blending obligations, citing economic hardship as a result of high RIN prices. Some refineries claim this causes higher gasoline prices. To be clear, there is no relationship between RIN prices and refinery profits, as EPA has repeatedly stated:

> "We do not believe that the price paid for RINs is a valid indicator of the economic impact of the RFS program on these entities [refiners], since a narrow focus on RIN price ignores the ability for these parties to recover the cost of RINs from the sale of their petroleum products." [19]

First, as EPA wrote in November 2018, refiners recoup the cost of RIN purchases when they sell petroleum products on the market. Any RIN cost is incorporated into the sell price, so refineries account for this during their transactions.

Figure 8: Price of Retail Gas, WTI Crude, and D6 RINs



Source EIA, EPA.

Second, refineries have had almost 14 years to comply with the RFS, a law which was constructed to encourage an increasing scale of biofuel blending. Supply and demand ultimately dictate price, so blending more biofuel creates more RINs, which

[19] "Renewable Fuel Standard Program—Standards for 2019 and Biomass-Based Diesel Volume for 2020: Response to Comments." Environmental Protection Agency, November 2018. *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100VU6V.pdf*.

in turn push RIN prices down. The easiest way to lower RIN prices is to blend more biofuels.

With respect to gas prices, as shown in *Figure 8,* gas prices are directly correlated with the price of crude oil, not RINs. According to the EIA, crude oil is the most impactful contributor, accounting for 56% of the price of gasoline.[20] The RIN market is independent from gas prices and instead reflects the blending decisions by obligated parties.

The RFS works best when it is implemented in accordance with Congressional intent. We encourage Members of this Subcommittee and the administrative bodies it oversees to maintain the integrity of the RFS.

Breaking Down Barriers to Biofuels: Marketplace Hurdles for Higher Blends

As stated earlier, a nationwide transition from E10 to E15 would lower GHGs by 17.62 million tons annually, the equivalent of removing 3.85 million vehicles from the road. Further, an ABF Economics study from June 2021[21] shows that moving to a nationwide E15 standard would offer even further economic benefits:

- Add $17.8 billion to the U.S. Gross Domestic Product
  - $27.9 billion would come from boosted corn production
- Create an additional 182,700 jobs
  - 76,000 of these would be in agriculture
- Generate $10.5 billion in new household income
- Save consumers $12.2 billion fuel costs annually
  - E15 is typically $0.05 to $0.10 cheaper than E10 due to the higher ethanol content

Agriculture jobs that would be supported by a nationwide E15 standard include farm advisors, producers, distributors of crop protection and fertilizer products, farm equipment, and other service providers. These jobs are typically located in rural parts of the United States and would greatly benefit from more biofuel production due to E15 expansion efforts.

However, the pathway to these higher-level ethanol blended fuels has regulatory hurdles and outdated policy assumptions. To fully realize these potential gains in economic growth and emissions reductions, we recommend Congress pass legislation, the Year-Round Fuel Choice Act (H.R. 4410), or EPA take relevant regulatory action to restore summer sales for E15 and complete a pending rulemaking that would clear unnecessary hurdles related to the pump labeling of E15 and clarify some potential refueling infrastructure hurdles.

Summer E15 Sales Restriction

The Clean Air Act includes seasonal fuel vapor pressure provisions intended to reduce evaporative emissions in the summer months (June 1 to September 15). In the 1990 amendments to the Clean Air Act, Congress limited allowable fuel vapor pressure during the summer months to 9 pounds per square inch (psi) Reid Vapor Pressure (RVP) in certain areas of the country. Congress also specified, however, that fuel blends containing 10% ethanol would receive a 1.0 psi RVP waiver from the seasonal RVP limit to encourage use of ethanol-blended fuels, which provide significant reductions in tailpipe emissions. This RVP waiver made the sale of E10 and lower ethanol blended fuels possible year-round throughout the country. However, the waiver predates the introduction of higher blends of ethanol like E15, which have a lower RVP than E10.

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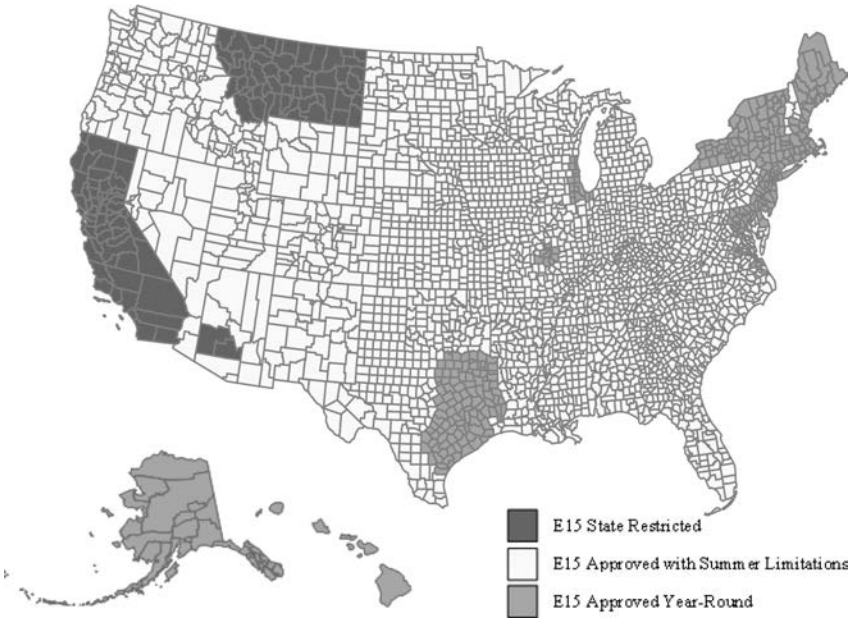
[20] U.S. Energy Information Administration. "Gasoline explained—Factors affecting gasoline prices," *https://www.eia.gov/energyexplained/gasoline/factors-affecting-gasoline-prices.php*.

[21] ABF Economics. "Economic Impact of Nationwide E15 Use," Urbanchuk, John M. June 10, 2021. *https://growthenergy.org/wp-content/uploads/2021/06/Nationwide-E15-Use-Economic-Impact-Final.pdf*.

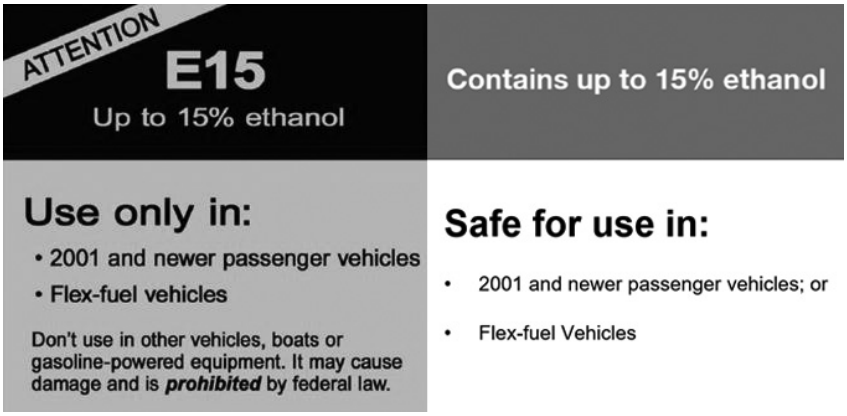


In May 2019, EPA clarified that E15 could be sold in the summer months, resolving ambiguity in the 1990 statute that arose because there was no 15% ethanol fuel at the time. Following this EPA rulemaking, the oil industry challenged this rulemaking in court. In a July 2021 D.C. Circuit Court of Appeals ruling, the court reversed EPA's interpretation, denying the majority of American drivers access to a cleaner, more affordable biofuel blend during the summer months starting on June 1, 2022. This move threatens the expansion of clean, homegrown renewable energy.

The DC Circuit ruling affects nearly 85% of retailers currently selling E15 across 30 states and creates needless uncertainty across the marketplace. We urge the Members of this Subcommittee to move swiftly to ensure uninterrupted access to lower-cost E15 for the summer of 2022 and beyond, particularly as consumers seek relief from rising gasoline prices. If not addressed, the court's decision would require E15 retailers to change out fuels twice a year (on June 1 and September 15), a costly and burdensome process that actually increases GHG emissions, counter to Congress' intent of providing cleaner fuel choices at the pump.

This decision impacts all non-reformulated gasoline markets throughout 33 states—conventional markets outside of urban areas that are not required to participate in our nation's reformulated gasoline program. In these areas, summer sales of E15 in retail sites could fall by 85%, and the new restrictions on E15 sales would also cut overall ethanol consumption and increase greenhouse gas emissions nationwide as more petroleum products would be used. This decision has no impact on long-standing rules that permit sales of E15 in RFG and other markets, which are found in 17 states. However, the largest concentration of RFG markets is in California and the Northeast, where the availability of E15 is already limited.

Labeling and Equipment Compatibility



Current EPA Label Growth Energy Proposed Label

In order to remove unnecessary barriers that prevent consumers from utilizing E15, Growth Energy supports EPA finalizing their proposed rule to address E15 Fuel Dispenser Labeling and Compatibility with Underground Storage Tanks that would erase market hurdles for E15 adoption. We support modifying the E15 label requirement to increase clarity and ensure it clearly advises consumers of appropriate uses of the fuel, while not unnecessarily dissuading the vast majority of consumers whose vehicles can refuel with E15.[22] Either modification of EPA's E15 label or removal of the E15 label requirement entirely would expressly preempt and conflict—preempt any state or local government E15 label requirement.

In addition, Growth Energy strongly supports EPA's proposal to modify the underground storage tank (UST) compatibility requirements applicable to E15 and other fuel blends. There is ample evidence that a wide variety of fuel storage equipment, including USTs and related piping, may store E15 if it is suitable for use with E10. Removing unnecessary impediments to retailers' use of such existing equipment is imperative to providing E15 equal footing in the fuels marketplace.

Fixing these outdated and confusing barriers are critical to ensuring we can capture the emissions reduction, farm income, and fuel price relief benefits that come with E15 expansion. As our nation faces the challenges of climate change, it is imperative that EPA act quickly to support greater access to cleaner renewable fuel blends for all Americans. E15 and higher ethanol blended fuels will deliver immediate benefits for our environment and are a critical piece of our nation's efforts to reduce carbon emissions. Clearing hurdles to the sale of E15 and growing markets of biofuels would also provide an economic lifeline for rural communities as they continue to rebuild in the wake of COVID.

The Future of Biofuels: De-carbonizing Land, Air, and Sea Transportation

As carbon reduction becomes more important to the transportation sector, ethanol is poised to play a greater role in de-carbonizing all forms of transportation—whether on land, in the air, or in the seas—and we are energized by the potential opportunity to expand our role in reducing our nation's carbon emissions. In addition to our current light-duty vehicle market, we see new and emerging low-carbon fuel markets in hard-to-electrify sectors such as aviation, marine, and heavy-duty vehicle markets. Earlier in this testimony, I discussed the potential incentive structure for sustainable aviation fuel. U.S. based airlines used more than 18 billion gallons of jet fuel in 2019.[23] Accessing the aviation market through ethanol to SAF, along with new technologies that allow ethanol to be used in marine and heavy-duty applica-

[22] Growth Energy Comment on EPA's NPRM "E15 Fuel Dispenser Labeling and Compatibility with Underground Storage Tanks" (Docket ID No. EPA–HQ–OAR–2020–0448): *https://www.regulations.gov/comment/EPA-HQ-OAR-2020-0448-0051.*

[23] "Airline Fuel Cost and Consumption (U.S. Carriers—Scheduled)," Bureau of Transporta[t]ion Statistics. *https://www.transtats.bts.gov/fuel.asp*.

tions provide America's ethanol industry the opportunity to be utilized in more than just light duty cars and trucks.

With the appropriate investment in critical research and development and the right policy environment, our industry can continue to de-carbonize our transportation sector—from passenger vehicles to our aircraft fleet. However, in order to achieve the Biden Administration's goal of 3 billion gallons of SAF production by 2030 and net-zero emission in aviation by 2050, we need game-changing solutions and for that we must have a healthy and thriving corn ethanol industry and rural economy. That starts with a strong RFS, a nationwide E15 standard, and accurate carbon modeling.

Ethanol Production Co-Products

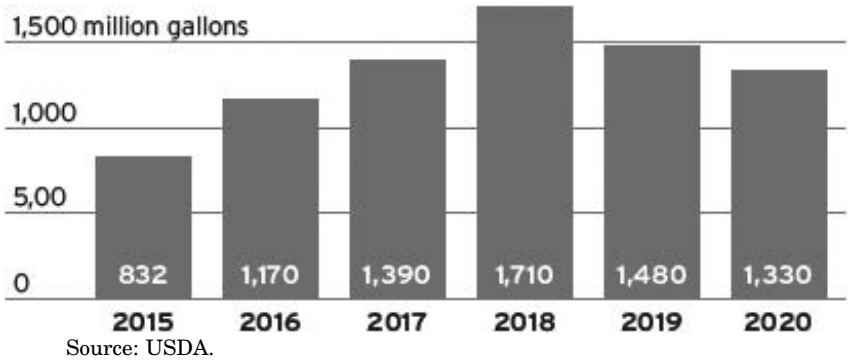
Ethanol biorefineries produce several valuable co-products, which are integral to related supply chains. The industry produced an estimated 43.6 million short tons of distiller's grains and nearly 3.9 billion pounds of distiller's corn oil (DCO) in 2019 with an aggregate market value for these products at $7.5 billion.[24] Distiller's grains are a high-protein feed purchased by local livestock farmers and provide a steady stream of animal feed for their farms. Roughly half of all DCO is used in animal feed, while the other half is used by the biomass-based diesel industry in their production process.

Additionally, about 50 biorefineries have the ability to capture a pure stream of carbon dioxide, which has a wide variety of uses including water treatment at municipal water facilities, food and beverage preservation. During the peak of the COVID pandemic, the ethanol industry also stepped up during a national hand-sanitizer shortage, converting ethanol production to produce high-quality, pharmaceutical-grade hand sanitizer for local hospitals and consumers. Captured carbon dioxide is also being used as dry ice for the safe transportation of COVID vaccinations.

Ensuring Access to International Markets for U.S. Ethanol

As nations around the globe are looking to achieve their carbon reduction goals, international markets are turning to biofuels as a solution. However, tariffs, technical trade barriers, and follow-through on trade agreements pose challenges to U.S. exporters looking to fulfill growing biofuel demand abroad.

Total U.S. Ethanol Exports by Year



Source: USDA.

The USDA designates an official trade representative who leads efforts on promoting U.S. agricultural products, including biofuels, abroad. USDA Secretary Vilsack has not yet selected a nominee to fill that position, but we encourage him to do so as soon as possible.

In 2020, U.S. ethanol exports totaled 1.33 billion gallons, which fell 9.8% compared to 2019.[25] The decline is almost entirely due to COVID's downward impact on gasoline demand, as shown in the graph [above]. Through Q3 2021, the U.S. ex-

[24] "Contribution of the Ethanol Industry to the Economy of the United States in 2019," Urbanchuk, John M., Managing Partner. February 4, 2020. *https://files.constantcontact.com/a8800d13601/9e769376-3aef-4699-b31f-3c6415b8fa63.pdf.*

[25] U.S. Department of Agriculture, Foreign Agricultural Service. "Biofuels," *https://www.fas.usda.gov/commodities/biofuels.*

ported 872.1 million gallons of ethanol. Unfortunately, this is on pace to fall below last year's export numbers by nearly 170 million gallons.

Growth Energy has been working closely in markets such as Brazil, Canada, India, Mexico and China to encourage the adoption of biofuels as a displacement to petroleum products. Expanding ethanol use around the world will boost domestic production and help countries meet their carbon reduction and clean air commitments at the same time.

Industry Assistance for COVID Losses

On June 15, 2021, USDA announced that it will provide $700 million in aid to support biofuel producers recover from the wake of the COVID pandemic. The funds will be distributed through USDA's Pandemic Assistance for Producers initiative to provide additional relief to the farmers that depend on a vibrant biofuels industry, however, no funds have been released to date.

Although the details on how these funds will be distributed remain opaque, Growth Energy has provided USDA the following suggestions, which we urge you to support:

1. **Assistance should only be available to biorefineries that were in normal operation between Jan. 1 and March 1, 2020.**

   As the emergency relief funding is intended to address only revenues lost as a direct result of COVID, ethanol biorefineries that were not operating normally prior to the pandemic should not qualify to receive assistance.

2. **Assistance levels should be the same on a per gallon basis for each biorefinery who seeks assistance.**

   Because each biorefinery in operation during COVID suffered the same economic injury due to the pandemic, each biorefinery should receive the same per gallon level of assistance. We recommend providing assistance of 10¢ a gallon based on each qualifying biorefinery's production in 2019, the last full year before COVID demand destruction.

3. **Payments made to biorefineries should be made public.**

   We support making available to the public information on which entities are receiving assistance and in what amount.

We are grateful for this support from USDA which reflects President Biden's repeated promises to support rural and clean energy jobs. However, we urge the USDA to release this funding as soon as possible. Many biofuel producers have yet to recover from the devastating drop in fuel demand due to COVID and are lacking certainty due to the delay in releasing the COVID aid.

Higher Octane Fuels Help to Drive Lower Vehicle Greenhouse Gas Standards and Better Fuel Economy

It is imperative to consider the benefits of using high-octane, low-carbon fuels to make engines more efficient. Beyond E15, Growth Energy has been a leader on the need for higher octane, mid-level ethanol blends, first submitting a proposal for a 100 RON, E30 fuel nearly a decade ago. By moving towards higher octane, lower carbon mid-level blends, automakers can optimize engines to further improve efficiency and further reduce both greenhouse gas and tailpipe emissions.

The science supporting the benefits of a high-octane, low-carbon midlevel blend in conjunction with a high compression ratio engine is not new, and has been well-explored by the national labs, automobile manufacturers, and other scientific institutions.[26] Ethanol has a very high octane number, a lower carbon content than the gasoline components it replaces, and myriad other benefits that assist in combustion to increase engine efficiency and reduce both greenhouse gas and tailpipe criteria pollutant emissions.

We urge the Committee to work with USDA, EPA, and the Department of Transportation to move quickly to require a minimum octane standard as well as to approve a high-octane, mid-level ethanol blend such as that first proposed by Growth Energy for vehicle certification as well as for consumer use. Additionally, we strongly support the Next Generation Fuels Act (H.R. 5089) introduced by Congresswoman Bustos. This important legislation would increase the use of high-octane, low-carbon biofuels while limiting the use of harmful petroleum additives. We would urge Congress to consider and enact this key legislation.

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[26] *See e.g.,* Oak Ridge National Laboratory, *Summary of High-Octane, Mid-Level Ethanol Blends Study* (July 2016), available at *https://info.ornl.gov/sites/publications/Files/Pub61169.pdf.*

Conclusion

The biofuel industry stands ready to work with Congress and the Biden Administration to meet our national commitments to attaining aggressive climate goals by mid-century while supporting rural development, working families, and renewable energy. With forward-leaning policies that support innovation and access to markets, our industry will continue to reduce our carbon footprint, create more clean energy jobs, spur economic activity in rural and farming communities, and provide drivers across the country with affordable, clean fuel choices today.

Congress can help accelerate our transition to a clean energy future and a prosperous rural America with some of the provisions in the Build Back Better Act that help reduce the carbon footprint of transportation. Infrastructure investments will expand consumer access to higher fuel blends of homegrown biofuels like E15. Ensuring the RFS is administered as intended by Congress will guarantee that we blend more low-carbon renewable fuel in our transportation sector each year. And reducing trade barriers to U.S. ethanol allows greater access to foreign markets, boosts our domestic production, and assists other countries in meeting their carbon reduction commitments.

In short, we have ample opportunity to achieve our renewable energy goals while supporting an industry that has supported rural America for decades. I appreciate the opportunity to participate in this important hearing on renewable energy's role for agriculture and rural economies.

Thank you and I look forward to answering your questions.

The CHAIRMAN. Thank you, Ms. Skor.

Mr. Pratt, please begin when you are ready.

STATEMENT OF JEFF PRATT, PRESIDENT, GREEN POWER EMC, TUCKER, GA; ON BEHALF OF NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Mr. PRATT. Thank you, Chairman Delgado, Ranking Member Fischbach, and Members of the Subcommittee. On behalf of Green Power EMC and 38 other member cooperatives in the State of Georgia, we really appreciate the opportunity to testify today.

I want to share with you the growth opportunities that we found in renewable energy in Georgia, and the challenges and opportunities that poses for rural America.

My name is Jeff Pratt, and I am the President of Green Power EMC, and our co-ops serve about four million Georgians, there are about 900 similar cooperatives across the country that serve about 56 percent of the mostly rural areas of this country.

In 2001, the electric co-ops in Georgia had a lot of foresight, and before it was popular, created Green Power EMC and focused on the procurement of renewable energy, mostly biomass energy and hydro energy. Since that time, though, in 2015, almost 14 years later, we created our first large-scale solar project in about 200 acres. Six years later, today we have committed to over 15,000 acres. That is about an 8,000 percent increase.

To that end, we have made great strides in reducing our carbon footprint in the State of Georgia through nuclear power and this renewable engagement. But in rural America, and in Georgia, most of our solar plants are located in these areas where there are challenges and competing land interests. So, we work very hard to make sure that we are good stewards of the land in those areas, and we do that in a couple of ways that I want to share with you.

One of them is to make sure there are no surprises to those rural communities, and make sure that we are very courteous and honor the local farms in meaningful ways. One of those is to create regenerative farming on the solar farm itself by putting sheep and man-

aging vegetation with livestock, and sequestering carbon underneath in the soil of those facilities as we do so.

There are other challenges with renewable energy in the State of Georgia, and while we have one of the most robust transmission and distribution systems in the country, the intermittent nature of renewable energy, especially solar in Georgia, creates challenges that will require investment and planning and dedication to make sure that we do not sacrifice reliability and affordability for all of our customers, which are very important, especially in those rural areas.

Some of the challenges are going to require technologies that are just emerging, that we are just learning to engage, and they are not cheap. Some of the provisions in the proposed legislation recently include opportunities that would help make some of that technology more affordable as it becomes available, provisions such as tax incentives. Tax incentives are very helpful, but in Georgia, we have some difficulty as not-for-profit utilities and extracting the full value of those tax incentives. So, we would be very supportive of direct pay.

Second, $10 billion, I understand, has been proposed to relieve debt burden and to invest in new clean technologies. All of those we would like to have in our quiver of tools to help increase our emission reductions in the state.

I would like to say that we are very supportive of all the efforts that the Committee is looking at here. We want to make sure that these efforts are affordable, the efforts do not sacrifice reliability, and bring opportunities to rural America, which is a big part of the areas in which our cooperatives serve.

Thank you very much, Mr. Chairman.

[The prepared statement of Mr. Pratt follows:]

PREPARED STATEMENT OF JEFF PRATT, PRESIDENT, GREEN POWER EMC, TUCKER, GA; ON BEHALF OF NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Chairman Delgado, Ranking Member Fischbach, and distinguished Members of the Subcommittee, on behalf of Green Power EMC and Georgia's electric cooperatives, thank you for the opportunity to testify on renewable energy growth across Georgia and the opportunities and challenges it presents for rural communities.

My name is Jeff Pratt and I am the President of Green Power EMC, the not-for-profit electric cooperative that secures renewable energy resources for the broader family of 38 Georgia electric cooperatives. Electric cooperatives (or, as we call them in Georgia, Electric Membership Corporations ("EMCs")) are not-for-profit electric utilities owned and operated by the communities they serve. In Georgia, electric cooperatives distribute power to their member-consumers—residents, businesses, and public institutions—approximately 4.3 million Georgians across 65% of the state's land area in 151 of 159 counties. Georgia's electric co-ops represent the largest group of cooperatives in the U.S. based on the number of end-use customers and their electrical load.

Around the country, there are approximately 900 electric cooperatives in 48 states serving 56% of the nation's landmass but only about 13% of the population. We operate in the most rural parts of the country and serve 92% of the country's persistent poverty counties. Our not-for-profit status and local control help us be nimble and innovative as we strive to meet evolving consumer demands.

Background

In 2001, long before it was popular to be "green," Georgia's electric cooperatives founded Green Power EMC to source renewable generation for the cooperative energy portfolio. Green Power EMC became the first renewable energy provider in the state of Georgia, aggregating the interest in renewables of small and large coopera-

tives alike, evaluating renewable energy alternatives, and recommending projects for cooperative participation.

In its early days, Green Power EMC procured energy from landfill gas projects. Later, Green Power EMC purchased power from Georgia's only certified run-of-river hydro facility. In 2010, Green Power EMC began purchasing energy from two of Georgia's first solar projects.

In 2015, through Green Power EMC, Georgia's cooperatives contracted for their first large-scale solar project—a 20 megawatt facility covering nearly 200 acres of land in south Georgia. In the past 6 years, Georgia's electric cooperatives have grown their solar portfolio by 8,000%, utilizing approximately 15,000 acres of land in rural Georgia. These solar projects will collectively produce enough electricity to serve more than 270,000 cooperative households each year. This growth is driven by market economics and consumer demand, without mandates by our state or Federal Government.

On behalf of its members, Green Power EMC continues to evaluate new solar opportunities as well as the potential for other renewable technologies including wind, biomass, and hydro projects. However, the significant decline in the cost of solar energy production equipment and the ample availability of sunlight in Georgia make solar energy the current most cost-effective means to provide affordable renewable power for our cooperatives.

From a Federal perspective, 491 electric co-ops in 43 states use solar energy, with a combined capacity, including utility-scale and community solar, of 1,374.8 megawatts. In addition to solar, electric cooperatives have been engaged in other renewable resources for many years. Nationally, we have nearly tripled our total renewable capacity from 3.9 gigawatts in 2010 to more than 11.4 gigawatts in 2020. That's enough energy to serve nearly 2.7 million homes. Additionally, co-ops have announced more than 6.4 gigawatts of new renewable capacity planned from 2021–2024. Because of our geographic diversity, electric cooperatives are significant stakeholders in solar, wind and hydroelectric generation assets.

Challenges and Opportunities

Technology and Intermittency: Georgia's electric cooperatives are committed to reducing greenhouse gas emissions, without sacrificing reliable and affordable electric service. While solar is among the lowest cost of energy in Georgia, the intermittent nature of this generating resource presents technical and economic challenges as it becomes a larger percentage of our electricity generation portfolio. As the volume of solar energy increases, so do necessary investments in technologies such as battery storage and new energy management control systems to maintain expected levels of reliability. While these technologies are advancing rapidly, the investment required to deploy these technologies is significant and the effectiveness to ensure reliability and affordability on a utility scale is largely unproven. While we wait for battery storage technologies to be perfected, Georgia relies heavily on base load power such as nuclear generation, to provide 24/7 reliability to balance the intermittency of our large solar portfolio.

Transmission and Distribution: Georgia has one of the most robust transmission and distribution systems in the United States. The transmission system is unique because the infrastructure is shared among the state's utilities through a structure called the Integrated Transmission System, which comprises joint system planning and minimizes redundant equipment. We are accustom to responding to changing market conditions with cost-effective and timely transmission system improvements. However, as higher levels of intermittent generation resources are connected to our transmission and distribution systems, it will be necessary to adjust our system planning and management practices, equipment, and control software to maintain current levels of reliability and resiliency.

A foundational program for most electric cooperatives in Georgia, and a key financial resource to help meet these transmission challenges, is the U.S. Department of Agriculture's Rural Utilities Service (RUS) Electric Loan program. Georgia's electric cooperatives utilize RUS loans for many basic functions of providing electricity to our state, such as building new distribution lines, installing smart meters, making environmental improvements to generation facilities, and strengthening transmission lines.

Programs like the RUS Electric Loan Program will help make many of these transmission system improvements possible. Many states may also take advantage of the new opportunities made available through the Infrastructure Investment and Jobs Act passed by Congress just a few days ago.

Co-ops and Federal Financial Incentives: Electric cooperatives are meeting today's energy needs and planning for the future, but historically we've been limited by the Tax Code and the costs of implementing new technologies. As not-for-profit

businesses, current law does not allow electric cooperatives to access the full value of clean energy tax incentives available to taxable businesses, including investor-owned utilities. Electric cooperatives need access to "direct pay" tax incentives to reduce the cost of energy innovation projects, including the deployment of renewables, nuclear energy and other emerging technologies, the expansion of energy storage projects, and installation of electric charging infrastructure. This direct pay option is included as part of the clean energy tax credits in current drafts of the Congressional budget reconciliation bill.

The current draft of the budget reconciliation bill also includes a proposed voluntary $10 billion USDA-based clean energy fund to assist electric cooperatives with outstanding debt on stranded generation assets or to facilitate the deployment of new clean energy sources. This program could help electric cooperatives grow green energy programs like we already have in Georgia.

Rural Economic Opportunity: Georgia's rural communities have realized great financial benefits from the growth in cooperative solar projects. These projects have created thousands of construction jobs for local citizens and contribute significant ongoing tax revenue for local economies and governments supporting health, emergency, and school services in rural communities across Georgia. In many cases, a large-scale solar project generates the largest tax revenue in the county.

Supply Chain: Rapid growth in demand combined with current global trade inefficiencies have increased the cost of solar equipment. Electric cooperatives are facing uncertainty about the availability of raw materials for all parts of our business, including the anticipated growth of our solar footprint in the coming months and years. This could be compounded by, and will need to be managed in concert with, the growth of new Federal incentives to incentivize more rapid renewable deployment.

Balancing Land Use Demands: Despite these economic benefits, as investments in solar projects increase, some communities have been challenged to find a balance between the competing interests of solar land use and traditional farming operations. The majority of the land area ideal for solar energy facilities in Georgia is rooted in rural agriculture. Georgia's electric cooperatives have a long history of providing electricity to these agrarian communities.

Green Power EMC and its members, in partnership with solar developers and innovative local agricultural leaders, are employing regenerative agriculture practices at solar farms, including land management using planned sheep grazing. Herds of livestock reside part-time at the solar farms and graze beneath the solar panels. As sheep bite off the tops of plants, keeping vegetation from shading the solar panels, they fertilize the soil, causing more plants to grow. This agricultural practice is designed to improve soil health, sequester carbon, and boost water quality on land used for solar power generation. This approach also generates new long-term revenue opportunities for farmers and the local communities and supports important agricultural jobs. Additionally, these practices also promise to provide measurable sequestration of carbon in natural systems thereby providing additional mitigation of climate change challenges that face our planet.

Conclusion

Green Power EMC and its member cooperatives are proud of Georgia's significant growth in renewable energy. We are committed to meeting the demands of a transitioning energy landscape in innovative ways that can support local economies while not sacrificing affordability or reliability. Thank you for conducting this hearing and for the opportunity to share how renewable energy is benefitting rural Georgia economies.

The CHAIRMAN. Thank you, Mr. Pratt.

Next, we have Mr. Wheeler. Please begin when you are ready.

STATEMENT OF GARY WHEELER, EXECUTIVE DIRECTOR AND CHIEF EXECUTIVE OFFICER, MISSOURI SOYBEAN ASSOCIATION, MISSOURI SOYBEAN MERCHANDISING COUNCIL, AND FOUNDATION FOR SOY INNOVATION, JEFFERSON CITY, MO; ON BEHALF OF AMERICAN SOYBEAN ASSOCIATION

Mr. WHEELER. Good morning, Subcommittee Chairman Delgado, Ranking Member Fischbach, Ranking Member Thompson, and

Members of the Subcommittee. It truly is an honor to testify before you on the renewable economy and what it means for America's soy farmers. I am Gary Wheeler, Executive Director and CEO of Missouri Soybean Association, the Missouri Soybean Merchandising Council, and the Foundation for Soy Innovation.

The Missouri Soybean Association, along with Missouri Soybean Merchandising Council and the Foundation for Soy Innovation, are affiliates of either the American Soybean Association, which represents 500,000 soybean farmers on domestic and international policy issues, or the United Soybean Board, which invests in checkoff funds to advance soybean marketing, production, technology, and development of new uses.

It may be obvious to the Members of this Committee that America's abundant supply of soybeans helps feed our country and the world. However, it is less known that U.S. companies now also offer approximately 1,000 soy biobased products, thanks to the versatile chemical composition of soybeans. When processed, soybeans are divided into protein and oil. Soy protein is around 80 percent of the bean and is primarily used in plant-based foods like tofu and in livestock animal feed, but is also an ingredient in plastic composites, synthetic fiber, paper coatings, adhesives, and more. Soybean oil, the remaining 20 percent of the bean, is one of the most versatile natural oils. Its molecular structure and suitable fatty acid profile can be used in many applications, from food use and cosmetics, to asphalt and biodiesel.

Bioproducts made from soy are sustainable. Unlike fossil fuel-based feedstocks, soybeans capture carbon dioxide from the atmosphere. In addition, most soybean acreage in the U.S. uses conservation tillage, which disturbs less soil and helps sequester carbon in cropland. Soy bioproducts also lower greenhouse gas emissions, reduce energy costs, and exposure to toxic chemicals by workers, and add credits toward LEED certification. There are also economic advantages to using soy in manufacturing and consumer products.

This year, growers are harvesting an immense crop of 4.4 billion bushels. This abundance has enabled soy ingredients to maintain an historic price advantage over petrochemical equivalents, and has helped reduce America's dependence on foreign oil.

Soy-based bioproducts create jobs. USDA's most recent report on the economic impact of the U.S. biobased products industry found that increasing demand for domestic biobased products added $470 billion and over 4.6 million direct and indirect jobs to the U.S. economy.

In Missouri, we partner with Cole County Sheriff's Department to demonstrate that Goodyear soy tires perform so well that they meet the demands of law enforcement. Goodyear determined that soybean oil mixes more readily with rubber compounds, reducing energy consumption and improving tire efficiency. Goodyear is now increasing soy oil consumption as part of their commitment to phase out petroleum-derived oils from products by 2040.

Another opportunity in the transportation sector is PoreShield, a soy-based concrete protector developed through a partnership among Purdue University, the Indiana Soybean Alliance, and the Indiana DOT. PoreShield is nontoxic and provides long-lasting concrete protection while replacing traditional sealants and elimi-

nating reliance on harmful solvents. My Indiana counterparts recently highlighted this award-winning product at the UN Climate Change Conference in Scotland.

As we continue to look at new markets, uses, and soybean research, I wanted to highlight the unique relationship between land-grant institutions and check-off investments in driving innovation. In one success story, the University of Missouri and USDA Agricultural Research Service are joint owners of the patent for SOYLEIC and MSMC is the exclusive licensee. SOYLEIC is a non-GMO, high oleic seed trait that can be incorporated in today's soybean varieties, resulting in high oleic oil and meal. These products demonstrate that we are off to a great start; however, the Federal Government needs to invest further for the renewable economy to truly take off.

First, Congress can urge EPA to fulfill its statutory authorities under the Renewable Fuel Standard to support American grown soy-based biofuels. Failure to release annual——

The CHAIRMAN. Mr. Wheeler, I am sorry. If you could wrap it up in the next couple seconds, that would be helpful.

Mr. WHEELER. Under the RFS created uncertainty in the biofuel markets, and this inaction continues to stymie the growth.

The nation's 500,000 soybean farmers are unified in their effort to grow market opportunities. By providing the best raw materials to create sustainable, biobased products, we stand ready to work with this Committee, Congress, and the Biden Administration to help grow the bioeconomy, great jobs, and enhance American sustainability.

I look forward to answering your questions and continuing this important discussion on the renewable economy. Thank you.

[The prepared statement of Mr. Wheeler follows:]

PREPARED STATEMENT OF GARY WHEELER, EXECUTIVE DIRECTOR AND CHIEF EXECUTIVE OFFICER, MISSOURI SOYBEAN ASSOCIATION, MISSOURI SOYBEAN MERCHANDISING COUNCIL, AND FOUNDATION FOR SOY INNOVATION, JEFFERSON CITY, MO; ON BEHALF OF AMERICAN SOYBEAN ASSOCIATION

Introduction

Chairman Delgado, Ranking Member Fischbach, and Members of the House Committee on Agriculture Subcommittee on Commodity Exchanges, Energy, and Credit, it is an honor to testify before you on the impact of the bioeconomy in rural America and what it means for America's soy farmers. My name is Gary Wheeler, Executive Director and CEO of the Missouri Soybean Association (MSA), Missouri Soybean Merchandising Council (MSMC), and Foundation for Soy Innovation (FSI).

MSA is a statewide membership organization designed to increase the profitability of Missouri soybean farmers through legislative advocacy, public policy initiatives, and education efforts across the state. MSMC is a farmer-run organization dedicated to improving the profitability of the Missouri soybean farmer through a combination of marketing, research, and commercialization programs. FSI builds strategic partnerships and leverages resources throughout the soy value chain to advance innovation and grow demand through partnership and scholarship.

The Missouri soy organizations are affiliates of either the American Soybean Association (ASA), which represents America's 500,000 [1] soybean farmers on domestic and international policy issues important to the soybean industry, or the United Soybean Board (USB), which invests check-off funds in programs and activities that advance soybean marketing, production, technology, and the development of new uses. MSA, MSMC, FSI, ASA, and USB are all farmer-led organizations.

America's soybean growers play an essential and growing role in the bioeconomy. It may be obvious to the Members of this Committee that America's abundant sup-

[1] USDA National Agricultural Statistics Service.

ply of soybeans helps feed America and the world. However, it is likely less known that U.S. companies now also offer approximately 1,000 soy biobased products made with ingredients grown on American family farms—thanks to the versatile chemical composition of soybeans.

When processed, soybeans are divided into protein and oil. Soybean protein (approximately 80% of the bean) is primarily used in plant-based foods like tofu and livestock animal feed, but it is also an ingredient in plastic composites, synthetic fiber, paper coatings, adhesives, and more. Soybean oil (the remaining 20%) is one of the most versatile natural oils; its molecular structure and suitable fatty-acid profile can be used in many applications, including biodiesel.

Bioproducts made with soy protein and oil are sustainable. Unlike fossil fuel-based feedstocks, soybeans capture carbon dioxide from the atmosphere. They also fix their own nitrogen for energy, limiting chemical-based fertilizer applications. In addition, most soybean acreage in the U.S. uses conservation tillage, which disturbs less soil, reduces fuel use, and helps sequester carbon on cropland. End-users continue to increase demand for sustainably produced products, and soy growers are ready to help deliver manufactured products with environmental benefits that include lower greenhouse gas emissions, reduced energy costs, lower volatile organic compounds (VOCs), reduced exposure to toxic chemicals by workers, credits toward LEED certification of certain finished products, and reduced processing costs and environmental compliance fees.

There are also economic advantages to using soy in manufacturing and producing consumer goods. Soybeans are renewable and abundant—this year soy growers are harvesting an immense crop of 4.4 billion bushels—which has enabled soy ingredients to maintain an historic price advantage over petrochemical equivalents and has helped reduce America's dependence on foreign oil. Soy-based bioproducts also create jobs. Released in 2021, USDA's most recent report on the economic impact of the U.S. biobased products industry found that American-made biobased products added $470 billion and more than 4.6 million direct and indirect jobs to the U.S. economy.[2]

Across America, cities, communities, companies, and government agencies are transitioning to plant-based products, limiting reliance on petroleum-based products while reducing greenhouse gas emissions. The increased production of biobased products to meet this demand contributes to the development and expansion of the U.S. bioeconomy, where society looks to agriculture for sustainable sources of fuel, energy, chemicals, and products.

Biobased Soy Products

Through the soybean check-off, U.S. soybean organizations are partnering with major companies and universities to create new rapidly renewable materials made with soy. It would be impossible to walk through the many biobased soy products on the record today, but I am pleased to use this hearing as an opportunity to highlight several soy biobased success stories and outline opportunities that this Committee and the Biden Administration have to further strengthen the bioeconomy.

In Missouri, we collaborated with the Cole County sheriff's department to demonstrate that Goodyear soy tires perform so well that they meet the demands of law enforcement. The Goodyear Tire & Rubber Company discovered that soybean oil mixes more readily with rubber compounds than other oils and reduces energy consumption, which improves tire manufacturing efficiency. Because of this achievement, Goodyear received the prestigious Tire Technology International Award for Innovation and Excellence in the "Environmental Achievement of the Year" category at the 2018 Tire Technology Expo. Incidentally, this same soy-based technology is now also delivering grip, stability, and durability in Skechers brand running shoes for men, women, and children thanks to a collaboration with Goodyear.

Goodyear's 2020 use of soybean oil increased 73% over 2018 usage, and this year the company announced a new sustainable soybean oil procurement policy and a commitment to phasing out petroleum-derived oils from its products by 2040, using soybean oil in its place.

Another exciting opportunity for highways, buildings, and more is PoreShield™, a revolutionary soy-based concrete protector that is the result of a partnership between Perdue University, Indiana Department of Transportation, and the Indiana Soybean Alliance. In addition to providing long-lasting concrete protection, PoreShield™ prevents pollution by replacing traditional, toxic concrete protectors

[2] Daystar, J., Handfeld, R.B., Pascual-Gonzalez, J., McConnell, E. and J.S. Golden (2020). *An Economic Impact Analysis of the U.S. Biobased Products Industry: 2019 Update.* Volume IV. A Joint Publication of the Supply Chain Resource Cooperative at North Carolina State University and the College of Engineering and Technology at East Carolina University.

and sealants, reducing VOCs by 90%, and eliminating the need for harmful solvents. As a nontoxic product, PoreShield™ is safe for the environment and workers and requires no personal protective equipment while applying. The product received the 2021 Indiana Department of Environmental Management Governor's Award for Environmental Excellence, and it also drew the attention of the U.S. Department of Agriculture, which invited Indiana soybean growers to highlight PoreShield™ at the U.N. Climate Change Conference (COP26) this month (Nov. 2021).

According to the Federal Highway Administration, there are more than 4 million miles of paved roads in the U.S. On average, 400 bushels of soybeans are used for every two-lane mile receiving a full surface PoreShield™ treatment. Using soy in such sustainable road construction and maintenance presents countless opportunities to support U.S. soybean farmers and boost local economies.

Soy has also demonstrated success in construction and paving by winning the American Chemical Society (ACS) 2021 Cooperative Research Award in Polymer Science and Engineering for "putting soy-based thermoplastics to work in the construction industry." The United Soybean Board and the Iowa Soybean Association contributed to research on a soy oil polymer that can replace petroleum-based polymers in asphalt paving. The cost-effective asphalt biobased polymer debuted in 2019, and it has been demonstrated in multiple municipalities and tested in 30 states. The soy-based polymer improves performance even while it promotes environmental stewardship—not only because it's biobased, but also because it allows for more recycled asphalt content. Importantly, soy-based polymer is cost competitive with asphalt paving materials that depend on foreign oil instead of U.S.-grown soybeans.

To highlight an exciting bioproduct currently in development, MSMC is partnering with Dr. Ram Gupta of the Kansas Polymer Research Center at Pittsburg State University to develop biodegradable, soy-based, high-performance golf balls. In general, golf balls are made of three layers: core, inner layer, and outer layer. We plan to use soybean-based composites for the core and soybean oil-based polyurethane coating as the outer layer. Golf is played by more than 60 million people around the world. In the United States alone, over 24 million people enjoy playing the game, including more than 8,000 professional players. More than 850 million golf balls are produced every year to fulfill that demand, but many are lost on the course or in the water and are never recovered, permanently cluttering natural areas. Utilizing soybean materials to serve this $550 million market will support agriculture and make the game of golf more eco-friendly, or what I like to call staying green on the green!

It's critical that we continue to push the envelope when it comes to new market uses and soybean research. The unique relationships between land-grant universities and check-off investments drive innovative technologies and traits that become industry standard. In one successful public-private partnership, the Curators of the University of Missouri and the USDA Agricultural Research Service are joint owners of the patent for SOYLEIC®, and MSMC is the exclusive licensee. The patented process is the product of a partnership between the University of Missouri, USDA, MSMC, and USB.

SOYLEIC® is a non-GMO, high-oleic seed trait that can be incorporated into today's soybean varieties, resulting in high oleic oil and meal. High oleic soybeans can be used in high-performing industrial applications. They also lack trans fats and have an extended shelf life, and the oil is more stable in baking and frying, helping create nutritious food for humans and feed for animal diets.

This type of public-private partnership is key to the success of growing a renewable rural America. The demand for high oleic soybeans is growing significantly, creating diversified and value-added options for farmers and opportunities for downstream customers in the U.S. and abroad. Proceeds from the sale of soybean varieties developed through the research program are then reinvested into soybean research—and growing demand and preference for U.S. soy around the world.

Soy-Based Biofuels

When talking about the benefits of soy-based bioproducts, perhaps there is no better example than soy-based biofuels. Biodiesel, renewable diesel, and sustainable aviation fuel are made from a variety of readily available feedstocks, including soybean oil. After the Food and Drug Administration started regulating trans fats in 2006, the demand for soy oil for food dropped significantly. Around the same time, we were developing new cooking oil options like high-oleic, soybean growers and others also worked to promote commercial production of biodiesel made from soybean oil—a biobased product that supports farmers and rural communities and diversifies our fuel supply while reducing emissions.

The growth of the biodiesel industry, and more recently the renewable hydrocarbon diesel industry, has been spurred by strong Federal and state-level policies that promote cleaner, lower-carbon energy sources, including the Renewable Fuel Standard. Biodiesel offers lower emissions solutions in the transportation and heating sectors, among others. With just under half of the homes in the northeast still reliant on home heating oil in the colder months, biodiesel blended into "Bioheat®" offers a lower-carbon alternative that meets state low-carbon standards while sparing homeowners from retrofitting their home heating systems. Looking toward the transportation sector, as the Administration seeks to move toward an electric vehicle-focused approach to lowering GHG emissions, biodiesel and renewable diesel can offer GHG emissions reductions of at least 50% compared to petroleum diesel in aging vehicles that still require liquid fuel and in heavy-duty vehicles that are more difficult to electrify.

Of note, government and corporate entities around the country are already utilizing biodiesel as an opportunity to achieve lower emissions. For example, New York City requires all 11,000 city fleet vehicles to use biodiesel—from vehicles used by the police and fire departments to those used by the department of sanitation and other off-road city equipment vehicles. New York City also uses Bioheat® to heat municipal and private buildings across the city. Other cities like Washington, D.C. are also transitioning their fleets to biodiesel. In 2018, D.C. used 120,000 gallons of biodiesel in its vehicle fleet, which resulted in 1,000 fewer tons of GHG emissions. Last year, the D.C. Department of Public Works announced it would begin running 17 garbage trucks on B100, or 100% biodiesel—an 86% GHG emissions reduction from a traditional petroleum-fueled garbage truck. The results are so clear that the city plans to double the size of its B100 vehicles in the next year. Through funds granted by EPA's Diesel Emissions Reduction Act program, D.C. Water Authority is expanding its use of B100 to 31 vehicles where it also benefits worker health. Soy farmers are proud of the success of biodiesel not only for the new market opportunities the fuel created for us, but also for being able to grow a clean energy solution right in our fields. Many of us use biodiesel in our own farming equipment.

Center for Soy Innovation

In Missouri, our own organization is setting an example by using these products. Our new Center for Soy Innovation in Jefferson City, Missouri, opened in March 2020 as a collaboration between MSMC, MSA, FSI, and other partners. The center showcases soy-based building materials and demonstrates new uses for soybeans, and it serves as a hub for biobased business development and incubation. Our living, hands-on displays illustrate the decades of research made possible by American soybean farmers and our industry partners, who continue to find new and innovative uses for soy. Some of the soy-based products on display include:

- Biodiesel, which powers the center's furnace.
- Columbia Forest Products' PureBond® plywood. The soy flour-based PureBond® adhesive won an EPA Green Chemistry Award and represents the first cost-competitive, environmentally friendly adhesive that replaced toxic urea-formaldehyde (UF) resin.
- Huntsman's Building Solutions's Heatlok® soy spray foam insulation. A high-performing versatile spray foam made with 14% renewable soybean oil and recycled plastics. Heatlock® is used in a wide variety of applications, including insulating the underside of bridges and tunnels. It can provide strength to structures and reduce water seepage and damage from freezing and thawing.
- Sherwin Williams paint, which received an EPA Presidential Green Chemistry Challenge Award in 2010 for its breakthrough paint formulation that uses both soybean oil and recycled plastic bottles. This technology eliminates use of thousands of barrels of oil and hundreds of thousands of VOCs.
- Signature Flooring high-performance carpet with soy backing, which offers a durable solution for commercial, high-traffic installations, has excellent moisture resistant properties and emits low VOC levels for improved indoor air quality. The Pentagon installed similar door mats in 2010 and continues to use them as a durable, cost-effective solution to help reduce the environmental footprint of the world's largest (and heavily trafficked) office building.
- SYNLawn® artificial turf, which uses soybean oil to displace 60% of the petroleum in its backing. This same turf is installed at Kennedy Space Center's Visitor Complex in the rocket launch viewing area and in more than 200,000 other installations in the U.S. plus 19 other countries. The SYNLawn® company is

adding 10% more soy to its products in 2021 and will start using sugarcane and other agricultural products as well.

- Cargill's Anova, a biobased asphalt rejuvenator, is featured in our parking lot. This product offers an important benefit, as it allows for increased use of recycled asphalt.

The Center for Soy Innovation was a $4 million investment in the Jefferson City community, bringing capital, jobs, and visitors to the region. There is no other facility like it, aggregating a soy education center, conference space, and research facility all under one roof. I invite all the Members of this Committee to visit the center for an up-close look at the soy biobased industry in action.

How can the government support biobased?

Biofuels Policy

The Federal Government is in a unique position to support and promote biobased products and the bioeconomy through policy and purchasing power. Since 2005, the Federal Government has supported growth in the biofuels sector through the Renewable Fuel Standard (RFS). The RFS, paired with other supports like USDA's Higher Blends Infrastructure Incentive Program, increases access to and demand for biofuels across the country. Unfortunately, over the past several years, EPA has failed to release annual Renewable Volume Obligations (RVOs) under the RFS in a timely manner. Failure to update these volume obligations has created uncertainty in the biofuels market, which directly impacts biofuel producers and has a negative downstream effect on growers. To date, the Administration has yet to fulfill its statutory requirement to release its 2021 or 2022 RVO under the RFS. Without action on RVOs, the Administration is missing a prime opportunity to promote lower-carbon fuel options for consumers and continues to stymie biofuels industry growth due to a lack of certainty in Federal support.

Federal Procurement and Coding

Beyond biofuels policy, the Federal Government has a unique opportunity to support the bioeconomy through its purchasing power. The U.S. Government is the single largest consumer in the world, purchasing more than $550 billion in goods and services each year. Through the 2002 Farm Bill and subsequent farm bills, Federal purchasing requirements for biobased products have been mandated and expanded. This requirement in the Federal Acquisition Regulation, supported by the USDA BioPreferred program, spurs growth in the biobased sector while creating new markets for soybean growers. Since 2002, ASA has supported farm bill provisions that created and enhanced the Federal BioPreferred Program at USDA. ASA has encouraged USDA to actively promote the use of biobased products to Federal agencies and other buyers.

Because someone develops a better product by using biobased content, it unfortunately does not mean that product has a guaranteed buyer. Federal agencies have a huge opportunity to drive demand for these products by doing what the farm bill promotes, which is to buy biobased products that are designated by USDA's BioPreferred Program.

Much like the USDA BioPreferred program, the North American Industry Classification System (NAICS)—the standard used by Federal statistical agencies in classifying businesses for the purpose of collecting and publishing statistical data about the U.S. economy—can be a tool to help spur growth in the biobased products space. NAICS is used domestically for various contracting and tax purposes, like state governments offering tax incentives for specific NAICS-coded industries. NAICS is also used by several Federal agencies for procurement programs, requiring a NAICS code be provided for each good or service procured. Unfortunately, NAICS does not currently include codes for biobased products manufacturers.

Through the 2018 Farm Bill, Congress issued a statutory directive to the Department of Commerce to develop a NAICS code specifically for biobased products manufacturers in coordination with USDA. Since that time, all annual revisions of NAICS codes have excluded biobased products. Without a NAICS code, many biobased products manufacturers get buried in other product classification codes that do not properly identify their products (*e.g.,* plastic, chemicals, packaging, *etc.*). Without these dedicated codes, data collection, statistical reporting, and consumer trend tracking are nearly impossible, thus hampering growth in the bioeconomy. ASA has urged the Office of Management and Budget, through its annual NAICS revision process, to heed Congress' directive to include a specific code for biobased products.

Research and Community Development

Aside from Federal procurement and coding, the government's support of research and community development can advance the renewable economy in America.

Federal support of land-grant universities and extension services is especially critical, and soy growers support increasing funding for these rural fixtures. These institutions are responsible for educating the next generation of farmers, ranchers, and citizens; through public-private partnerships—such as the collaboration that created SOYLEIC®—they provide the foundation for America's leadership in research and development; and by fostering innovation and entrepreneurship, they boost communities and economies.

Another exciting new development is the inclusion of a pilot program in the bipartisan infrastructure bill to study the environmental benefits of biobased construction materials and consumer goods. As mentioned earlier, soybean farmers have long supported the development of a wide variety of biobased products and are hoping that this pilot program will provide another opportunity to highlight the benefit of these products—especially soy-based construction materials, which have proven success in projects administered by state departments of transportation but have yet to be utilized by the U.S. Department of Transportation (DOT).

Furthermore, USDA, DOT, Department of Defense, and other agencies can use their programs to promote use of biobased products across the nation through their partnerships with states and local communities. There will never be a robust bioeconomy without leadership that literally paves the way for others to see that biobased products perform as well as—or better than—alternatives. It is essential that Federal agencies incorporate biobased products throughout their programming.

Last, we are grateful that funding from USDA Rural Development contributed to the construction of our Center for Soy Innovation. Rural development programs can drive community demand for biobased products during the USDA-supported construction of local buildings and infrastructure projects. Rural communities would benefit through increased demand for biobased products using the very same products grown in local farmers' fields, while at the same time contributing to the sustainability of USDA-supported facilities.

Conclusion

Chairman Delgado, Ranking Member Fischbach, and Members of the Subcommittee, thank you again for the opportunity to testify on the importance of biobased products and the significant contributions of America's soybean farmers to the bioeconomy. The nation's 500,000 soybean farmers are unified in their effort to grow market opportunities by providing the best raw materials to create sustainable, biobased products. U.S. soy farmers are leaders when it comes to using leading-edge technologies and best management practices to increase economic and environmental sustainability, and I am grateful for the opportunity to represent my peers in the soy industry here today.

The soy industry stands ready to work with the Committee and Subcommittee, Congress, and the Biden Administration to help grow the bioeconomy, create jobs, and enhance American sustainability.

Thank you.

The CHAIRMAN. Thank you, Mr. Wheeler.

Ms. Bowman, please begin when you are ready.

STATEMENT OF JESSICA BOWMAN, EXECUTIVE DIRECTOR, PLANT BASED PRODUCTS COUNCIL, WASHINGTON, D.C.

Ms. BOWMAN. Good morning, Chairman Delgado, Ranking Member Fischbach, and Members of the Subcommittee. I am Jessica Bowman, Executive Director of the Plant Based Products Council. Thank you for the opportunity to talk with you today about plant-based products and the role that they can play in a renewable economy in rural America.

So, with plant-based products, we can use a variety of feedstocks, from corn, to soy, to hemp, even agricultural waste materials, to make many of the products that we use every day, plastics, textiles, personal care products, building materials, and more. The

vast majority of these products are recyclable or compostable at their end-of-life.

Plant-based products present an immense economic opportunity for rural America. A recent report from USDA showed that this industry grew 27 percent from 2013 to 2017, bringing $470 billion in value to the U.S. economy, and supporting 4.6 million American jobs. These are often high-paying quality STEM jobs like chemists, engineers, and accountants. But the overall U.S. bioeconomy accounts for less than 2½ percent of the U.S. economy, so we are really just scratching the surface here.

This industry also represents the future of American agriculture's role in providing innovations and solutions that can reduce greenhouse gas emissions, and also move us to a more circular bioeconomy where we are minimizing waste, using more renewable resources, and keeping those resources in use longer. USDA estimates that plant-based products have the potential to reduce greenhouse gas emissions by 12.7 million metric tons of CO_2 equivalence per year.

To support growth of the circular bioeconomy and the plant-based products industry, there are a few ways that Congress can help. One is to make the plant-based products industry more visible through better data. One critical action that is needed and was actually included in the 2018 Farm Bill is the establishment of North American Industry Classification codes, or NAICS codes, for biobased product manufacturing. These codes are really key to the future success of this industry, because they allow for effective and accurate tracking and analysis of the economic activity and growth of the industry. So, we urge Congress to call for the Administration to fulfill the 2018 Farm Bill mandate.

It is also critical to make sure that the data regulators are using to assess plant-based products is based on best available science and modeling. Another opportunity is to modernize USDA's BioPreferred Program. The program has had a lot of success in its history, but we believe there is the potential to do much more. We think this program could gain household name recognition, much like EPA's EnergyStar program, but it has a fraction of the budget so it is really hampered in being able to fulfill that potential.

And finally, helping communities develop essential end-of-life infrastructure. It is important for all products to have the end-of-life infrastructure that supports a circular path, but one significant opportunity that can really help tackle our waste management challenges while also generating quality local jobs is in expanding composting infrastructure. I mentioned that many plant-based products are compostable. They are compostable in industrial composting facilities. So, when those products are used in a food contact application like packaging, they present an opportunity to divert substantial food waste to composting so it is not contaminating the recycling stream, or going to a landfill where it contributes to significant landfill methane emissions.

So, the COMPOST Act (H.R. 4443, Cultivating Organic Matter through the Promotion Of Sustainable Techniques Act), which Congresswoman Julia Brownley introduced in the House in July, represents an example of how the Federal Government could provide financial resources to help local communities, NGOs, nonprofits

and the private-sector to build out composting infrastructure systems that meet their community needs. So, we are eager to work with the Committee on the best way to achieve that goal.

I wanted to close by highlighting one of our member companies, Green Dot BioPlastics. This is a Kansas-based company. They are using plant-based feedstocks that are grown by American farmers to make more sustainable bioplastics that are used in everything from toys to car parts. And in rural Kansas, their employees are making two to three times the average salary in their community, and they are helping their customers re-shore jobs back to the U.S. That reduces production time, cost, and environmental impacts. So, with Congress's support, the plant-based products industry can bring a new generation of innovation and jobs to rural America.

Thank you, and I look forward to your questions.

[The prepared statement of Ms. Bowman follows:]

PREPARED STATEMENT OF JESSICA BOWMAN, EXECUTIVE DIRECTOR, PLANT BASED PRODUCTS COUNCIL, WASHINGTON, D.C.

Good morning, Chairman Delgado, Ranking Member Fischbach, and Members of the Subcommittee. My name is Jessica Bowman, and I serve as Executive Director of the Plant Based Products Council or PBPC. PBPC is an association representing a broad range of companies who support greater adoption of products and materials made from renewable, plant-based inputs.

Thank you for the opportunity to appear before you to discuss the renewable economy in rural America.

With plant-based products, we use a wide variety of feedstocks, from corn to soy to hemp, even agricultural waste materials, to make many products that consumers and industry rely on every day. Plant-based chemicals and materials are used to make plastic packaging, textiles, personal care products, building materials, and more, the vast majority of which are recyclable or compostable.

Plant-based products present an immense economic opportunity for rural America. A recent report from USDA showed this industry grew over 27% between 2013 and 2017, bringing $470 billion in value to the U.S. economy and supporting 4.6 million American jobs with annual wages of up to $96,000. These jobs are diverse, and many are STEM-based like chemists, engineers, and accountants. But the overall U.S. bioeconomy accounts for less than 2.5% of American economic activity, so we are only scratching the surface.

The plant-based products industry represents the future of American agriculture's role in providing technology, innovations, and solutions that help reduce greenhouse gas emissions and move the U.S. to a more circular bioeconomy where we are minimizing waste, using more renewable resources, and keeping those resources in use longer. USDA estimates that plant-based products have the potential to reduce greenhouse gas emissions by an estimated 12.7 million metric tons of CO_2 equivalents per year. That's equal to taking over 2.7 million cars off the road for a year.

To support growth of the circular bioeconomy, including the plant-based products industry, Congress can help in several ways:

1. Make the plant-based products industry more visible through better data.

- One critical action that is needed, and in fact was mandated in the 2018 Farm Bill, is the establishment of North American Industry Classification System (NAICS) codes for biobased product manufacturing. Such codes are key to the future success of the industry because they allow for accurate and effective tracking and analysis of the economic activity and growth of the industry. We urge Congress to call for the Administration to fulfill the 2018 Farm Bill mandate.
- It is also critical to ensure that data used by regulators to assess plant-based products is based on best available science and modeling.

2. Modernize USDA's BioPreferred Program.

- USDA's BioPreferred Program has several successes in its history, and we believe the program could do a great deal more. We think this program has the potential to gain household name recognition like EPA's Energy Star program,

but with a fraction of the budget, BioPreferred is extremely hampered in fulfilling its potential.

3. Help communities develop essential end-of-life infrastructure.

- It is important to provide the end-of-life infrastructure that supports a circular path for all products. One significant opportunity that can help tackle our waste management challenges while generating quality local jobs lies in the expansion of composting infrastructure. Many plant-based products are compostable in industrial composting facilities. When used in food contact applications, these materials present an opportunity to divert substantial food waste to composting, avoiding food waste contamination in the recycling system, and significantly reducing landfill methane emissions. The COMPOST Act (H.R. 4443), which Congresswoman Julia Brownley introduced in the House in July, represents an example of how the Federal Government can provide financial resources to help local governments, nonprofits, and the private-sector build composting systems that meet their community needs. We are eager to work with the Committee on the best way to achieve this goal.

Renewable and biobased products offer new rural development opportunities. I'll close by highlighting one of our member companies, Green Dot Bioplastics. This Kansas-based company is using plant-based feedstocks grown by American farmers to make more sustainable bioplastics used in everything from toys to car parts. In rural Kansas, their employees make 2–3 times the average salary in their community, and they are helping their customers re-shore jobs back to the U.S., moving their manufacturing facilities down the road instead of across the ocean. This reduces production time, costs, and environmental impacts. With Congress's support, the plant-based products industry can bring a new generation of innovation and jobs to rural America.

ATTACHMENTS

[Fact Sheet]

PBPC Advocacy Agenda Brief

Who We Are: The Plant Based Products Council (PBPC) includes businesses, small and large, from all links in the plant-based products supply chain. PBPC is working to grow the circular bioeconomy by encouraging greater use of plant-based materials in products and packaging, along with supporting infrastructure to ensure these materials can be composted, recycled, or otherwise repurposed.

Plant-based products made from renewable resources present an opportunity to:

- **Respond to increased consumer demand for more sustainable products and packaging**
- **Address a number of environmental challenges, including climate change and our growing waste management crisis**
- **Help bring quality manufacturing jobs to rural America**

To support growth of the circular bioeconomy, including the plant-based products industry, Congress can help incentivize the manufacture and use of plant-based products, spur job creation, support expansion of end-of-life infrastructure, foster workforce development, and fund needed research and development.

117th Congress Advocacy Agenda

USDA Research

Economic studies

- An apples-to-apples comparison of the U.S. bioeconomy's size and scope, including direct/indirect jobs and average wages, economic output, tax payment contributions, and investment, with other major economic regions.
- An assessment of how investment in rural America to expand plant-based product production could affect local and state economies as well as the need for worker training, infrastructure, and other public services.

Environmental studies

- A projection of the total greenhouse gas emissions that could be avoided if food waste and compostable packaging is diverted from landfills to composting facilities.

- A synthesis of existing life cycle analyses for key biobased products (*e.g.,* common bioplastic resins, molded fiber, biobased textiles) to show the current environmental impact data in various categories.

Bioproduct Recognition

- Establishment of North American Industry Classification (NAICS) codes for biobased products to allow for effective measurement of this growing industry.
- Ensure appropriate consideration of biobased plastics in plastics-focused legislation and other policy efforts.

Infrastructure

- Authorization of a composting infrastructure loan/grant program at USDA to support the development of economically viable composting facilities.

Tax Incentives

- Establish tax incentives to support the manufacture and market expansion of plant-based products.

Appropriations

- Increase appropriations to USDA's BioPreferred Program to support broader growth and public awareness of the program.
- Increase appropriations to the full authorized level of funding ($25M/year) for grants under the Urban Agriculture & Innovation Production Program established in the 2018 Farm Bill.
- Support appropriations through programs such as USDA's National Institute of Food and Agriculture or the National Science Foundation to increase research, education and training in plant-based products manufacturing, engineering, and agronomy.

For more information, contact Robin Bowen, PBPC Vice President of External Affairs, at *robin@pbpc.com*

[Comment Letter]

Organizations: Plant Based Products Council (PBPC), Corn Refiners Association (CRA), American Soybean Association (ASA), National Corn Growers Association (NCGA), Plastics Industry Association (PLASTICS), Alternative Fuels and Chemicals Coalition (AFCC), Ag Energy Coalition (AgEC)
Date: August 16, 2021
Subject: NAICS Updates for 2022
FR Reference: *Federal Register*/Vol. 86, No. 125/Friday, July 2, 2021/Notices
Docket Number: USBC–2021–0004

The undersigned organizations appreciate the opportunity to provide input in response to the Office of Management and Budget's (OMB) July 2, 2021 solicitation for comments on the Economic Classification Policy Committee's (ECPC) recommendations for the 2022 revision of the North American Industry Classification System (NAICS); update of Statistical Policy Directive No. 8, Standard Industrial Classification of Establishments; and elimination of Statistical Policy Directive No. 9, Standard Industrial Classification of Enterprises.

We disagree with the conclusion of the ECPC that a NAICS code for renewable chemicals manufacturers and biobased products manufacturers is not warranted and respectfully request OMB implement the statutory directive in the 2018 Farm Bill [1] immediately.

The Bioeconomy and Biobased Products

USDA defines bioeconomy as "[t]he global industrial transition of sustainably utilizing renewable aquatic and terrestrial resources in energy, intermediates, and final products for economic, environmental, social, and national security benefits." [2] According to USDA, the U.S. biobased products industry expanded more than 27% in terms of value added between 2013 and 2017, contributing roughly $470 billion of value to the U.S. economy. In 2017, the U.S. biobased products industry sup-

[1] Pub. L. No. 115–334, *H.R. 2, the Agriculture Improvement Act of 2018.* 115th Congress. § 9002(f)(1). *https://www.congress.gov/bill/115th-congress/house-bill/2.*

[2] Golden, Jay S. *et. al. An Economic Impact Analysis of the U.S. Biobased Products Industry: A Report to the Congress of the United States of America* (2015) pp. 201–209, *https://www.researchgate.net/publication/280979090_An_Economic_Impact_Analysis_of_the_US_Biobased_Products_Industry_A_Report_to_the_Congress_of_the_United_States_of_America.*

ported 4.6 million direct and indirect jobs,[3] an increase of 580,000 jobs from 2013. In terms of environmental benefits, the biobased products industry displaces about 9.4 million barrels of oil through replacing traditional products, as well as the potential to reduce greenhouse gas emissions by 12.7 million metric tons of carbon dioxide equivalents per year.

Biobased products derived from renewable agricultural commodities are an important part of the U.S. and global bioeconomy. Biobased products span a diverse array of product categories including renewable chemicals, cleaning supplies, packaging, furniture, and clothing. Globally, the biochemicals market alone is expected to grow from $6.5 billion in 2016 to $23.9 billion by 2025.[4]

Importance of NAICS Codes to the Bioeconomy

Distinct NAICS codes for manufacturers of renewable chemicals and biobased products are key to the future success of these biobased industries. Stakeholders across the U.S. economy, including industry, academia, research, and government agencies, struggle to track and analyze the economic activity and growth of the bioeconomy as a whole as well as biobased product segments due to the absence of distinct NAICS codes. Several academic researchers and economists, in attempting to measure the bioeconomy, repeatedly highlighted that the present NAICS system "does not provide an effective means of tracking the economic and job implications of the biobased products sector in the United States."[5] Academic researchers and economists expressly join industry groups calling for unique NAICS codes to improve measurement and economic contributions of the bioeconomy.[6] Below are a few examples of these sentiments:

- USDA. *An Economic Impact Analysis of the U.S. Biobased Products Industry* (2015):
  - "NAICS does not provide an effective means of tracking the economic and job implications of the biobased products sector in the United States. This results from a lack of industry-specific codes that were representative of the biobased products sectors of the economy. Many economists and industry groups recommended that NAICS codes be developed for biobased products and that reporting requirements be established to allow more effective tracking."[7]
- Robert Carlson, *Estimating the biotech sector's contribution to the US economy* (2016):[8]
  - "Consequently, using the current NAICS to estimate biotech employment is a difficult proposition, because the current codes do not map well onto existing and emerging bioproduction methods. Modernizing the NAICS must be a priority of both the public- and private-sectors to enable accurate economic analyses, employment measurements and appropriate marshaling and allocation of resources."

Without dedicated NAICS codes, data collection and statistical reporting for the rapidly growing bioeconomy are severely hampered. The absence of specific industry NAICS codes also masks the growth, market developments, and trends in these biobased industries, handicapping efforts by policymakers, businesses, investors, and industry stakeholders to make well-informed decisions.

Better data is particularly important to policymakers, which is why Congress included a directive on NAICS codes for biobased products in the 2018 Farm Bill. Biobased products can contribute to efforts to reduce greenhouse gas emissions, particularly methane emissions from landfills, as well as improve soil and water qual-

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[3] Daystar, Jesse *et. al. An Economic Impact Analysis of the U.S. Biobased Products Industry: 2019 Update.* United States Department of Agriculture BioPreferred® Program (2019) pp. 6–7. *https://www.rd.usda.gov/sites/default/files/usda_rd_economic_impact_analysis_us_bio based_products_industry.pdf.*

[4] Guo, Mingxin and Song, Weiping. *The Growing U.S. Bioeconomy: Drivers, Development, and Constraints.* NEW BIOTECHNOLOGY (2019) p. 54. *https://doi.org/10.1016/j.nbt.2018.08.005.*

[5] Golden, J.S., Handfield, R.B., Daystar, J. and, T.E. McConnell. *An Economic Impact Analysis of the U.S. Biobased Products Industry A Report to the Congress of the United States of America.* U.S. Department of Agriculture (2015) p. 83.

[6] Golden, J.S., Handfield, R.B., Daystar, J., and McConnell, T.E., *An Economic Impact Analysis of the U.S. Biobased Products Industry.* U.S. Department of Agriculture (2016) p. 13.

[7] Golden, Jay S. *et al. An Economic Impact Analysis of the U.S. Biobased Products Industry: A Report to the Congress of the United States of America.* INDUSTRIAL BIOTECHNOLOGY 11 (2015). *https://www.researchgate.net/publication/280979090_An_Economic_Impact_Analysis_of_the_US_Biobased_Products_Industry_A_Report_to_the_Congress_of_the_United_States_of_America.*

[8] Carlson, R. *Estimating the biotech sector's contribution to the US economy.* NAT. BIOTECHNOLOGY 34, 247–255 (2016). *https://doi.org/10.1038/nbt.3491.*

ity. President Biden's Plan to Build Back Better in Rural America has a specific goal to grow the bioeconomy and biobased manufacturing to bring cutting-edge manufacturing jobs back to rural communities.[9] It is clear that expanding the biobased products industry is part of the policy and economic growth goals of both Congress and the Biden Administration. NAICS codes for biobased products are a key tool in helping the private- and public-sectors achieve multiple objectives.

Concerns with the ECPC Recommendation

Currently, manufacturers of biobased products are by default hidden in a smattering of NAICS code product classifications (*e.g.,* plastic, chemicals, packaging). In the July 2, 2021, OMB Economic Classification Policy Committee (ECPC) response to public comments requesting the development of NAICS codes for biobased chemicals and products, the ECPC stated that "based on the data provided in supporting documents of the proposal, the current market sizes for manufacturing of renewable chemicals and biobased plastic resins are not significant enough in the economy to create new NAICS industries. Due to disclosure concerns, creating NAICS industries for the manufacture of these biobased goods is not recommended at this time."

Stakeholders of the biobased products industry have multiple concerns with the ECPC recommendation.

First, the ECPC recommendation ignores the clear legislative directive stated in Sec. 9002 of the 2018 Farm Bill, the Agriculture Improvement Act of 2018. Sec. 9002 provides that "[t]he Secretary and the Secretary of Commerce shall jointly develop North American Industry Classification System codes for—(A) renewable chemicals manufacturers; and (B) biobased product manufacturers."[10] This unambiguous directive compels USDA and Commerce to jointly develop NAICS codes for biobased product manufacturing.

Second, available data in fact demonstrate that there is strong growth and increased demand for biobased products. Over the past 10 years, USDA's BioPreferred program has certified more than 4,700 individual products at 930 companies.[11] While this is impressive, this is only a snapshot of the total amount of biobased products available in any number of product categories. Looking to the private-sector, many companies are making significant investments in biobased product manufacturing with an eye toward long-term growth that contradict the assertion that the market size and potential for these products is small. For example, biotechnology company Danimer Scientific announced in March of this year that it plans to invest $700 million in expanding one of their bioplastic manufacturing plants, adding 300 employees, nearly quadrupling their workforce at this facility, by 2023.[12] Another example, Ecoproducts, a brand of one of the largest American packaging companies, Novolex, just opened up a new product line of biobased compostable cups in June 2021, with plans to serve biobased packaging markets in the U.S. and globally.[13] Many bioplastics were sold out for 2021 by midyear. These examples do not indicate a small industry struggling to show demand for its products, rather this indicates an industry ready to expand further and meet the demands of an evolving domestic and global economy in which consumers are demanding more sustainable products derived from renewable materials.

Request

Consistent with the express legislative directive of the 2018 Farm Bill, the undersigned stakeholders request that OMB and the ECPC work with USDA and Commerce to immediately develop NAICS codes for renewable chemicals and biobased product manufacturers as required by statute.

NAICS codes are essential for the success of the biobased products industry as well as the future of the U.S. bioeconomy. It is imperative that these codes be developed so that the economic and environmental benefits associated with a robust domestic bioeconomy can be fully realized.

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[9] The Biden-Harris Plan to Build Back Better in Rural America. *https://joebiden.com/ruralplan/*.

[10] *Agriculture Improvement Act of 2018* § 9002. *https://www.congress.gov/115/plaws/publ334/PLAW-115publ334.pdf*.

[11] *BioPreferred 10 Year Anniversary Infographic. https://www.biopreferred.gov/BioPreferred/faces/pages/articles/TenYears.xhtml*.

[12] *Danimer Scientific Planning $700 million, 400-Job Expansion in Decatur County.* Danimer Scientific press release. March 2021. *https://danimerscientific.com/2021/03/30/danimer-scientific-planning-700-million-400-job-expansion-in-decatur-county/*.

[13] *Novolex Launches New U.S. Manufacturing Line to Make Compostable Cups from Plant-Based Plastic.* Novolex press release. *https://www.prnewswire.com/news-releases/novolex-launches-new-us-manufacturing-line-to-make-compostable-cups-from-plant-based-plastic-301314575.html?tc=eml_cleartime*.

Thank you for your consideration of these comments. Should you have any questions, please contact either or both of the following individuals:

- Jessica Bowman at 202–331–2028 or *Jessica@pbpc.com*
- Lloyd Ritter at 202–215–5512 or *Lritter@greencapitol.net*

Sincerely,

[Plant Based Products Council (PBPC)]

[Corn Refiners Association (CRA)]

[American Soybean Association (ASA)]

[Plastics Industry Association (PLASTICS)]

[National Corn Growers Association (NCGA)]

[Alternative Fuels and Chemicals Coalition (AFCC)]

[Ag Energy Coalition (AgEC)]

[Fact Sheet]

Plant-Based Leaders: Green Dot Bioplastics

"Our customers have a genuine desire to make something that is more sustainable and less damaging to the environment."

MARK REMMERT, *CEO,* Green Dot Bioplastics

Nearly 10 years ago, visionary investors saw an opportunity to replace fossil-fuel based plastics with similar materials sourced from renewable agriculture instead of petroleum.

CEO Mark Remmert, a Kansas native, was hired to build the firm, called Green Dot Bioplastics, from scratch.

Mark had spent decades in Europe and Asia leading multinational chemical companies who specialized in traditional plastics and he chose rural Kansas as the start-up's headquarters.

Many were surprised by the choice, but Mark had a vision for the company and the community.

As he has fulfilled that vision, the company has carved a path that could serve as a roadmap for revitalizing much of rural America.

Marine Degradable Bioplastics

Green Dot Bioplastics sells its products to manufacturers and brand owners large and small, including well-known brands and Fortune 500 companies. They come to Green Dot Bioplastics when they want to make a product that is better for the environment but retains the features of traditional plastic.

Some customers are exceptionally knowledgeable, including plenty of plastics professionals who arrive with product specifications, such as tensile strength, melt flow, shrink rates, and other standard plastics requirements.

Others arrive with a simple goal: they want to do better by the planet.

"Our customers have a genuine desire to make something that is more sustainable and less damaging to the environment," said Mark.

"They reach out seeking to reduce their carbon footprints, lessen global waste and pollution, or to find sustainable raw materials for their products," added Mark. "And we can help them achieve all three goals, and more besides."

His most promising products today are marine degradable bioplastics.

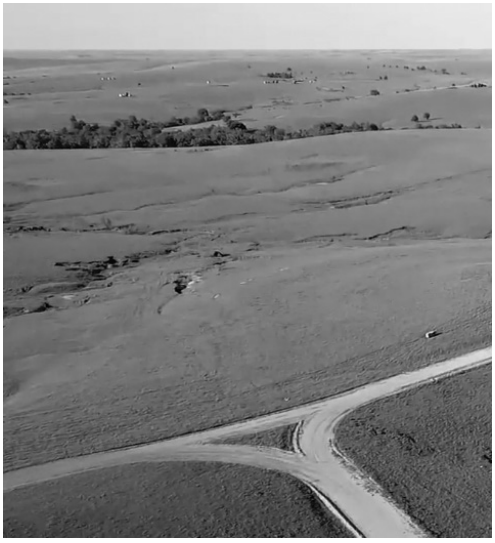
"Several years ago, we invented the chemistry and then created the process to make a line of plant-based polymers that are not only industrial compostable but also backyard, soil, and marine biodegradable," said Mike Parker, Director of Research and Development proudly.

"We're certainly not advocating that plastic should end up in the ocean," Mark quickly added. "But we are all aware this does happen, and our material will biodegrade in weeks instead of decades."

From Farm to Factory

The process begins with a range of different agricultural inputs: wheat, potatoes, corn, cassava, and wood are just a few of the company's plant-based sources. Agricultural processors like ADM or Cargill buy these commodities from farmers, plus their leaves, stalks, and inedible parts some might call waste. Then, the companies process the inputs down to starches, proteins, and fibers.

Green Dot Bioplastics buys these nearly-raw materials and hands them over to their chemists on staff who create new materials from them.



Today, the company has dozens of plant-based plastics and drop-ins with a wide variety of purposes and mechanical properties.

At this stage in manufacturing though, the bioplastics simply look like small, spherical pellets. The magic occurs when these pellets are fed into plastics manufacturing equipment and molded, extruded, or blown into the same products, indistinguishable from their petroleum cousins, except when it comes to sustainability.

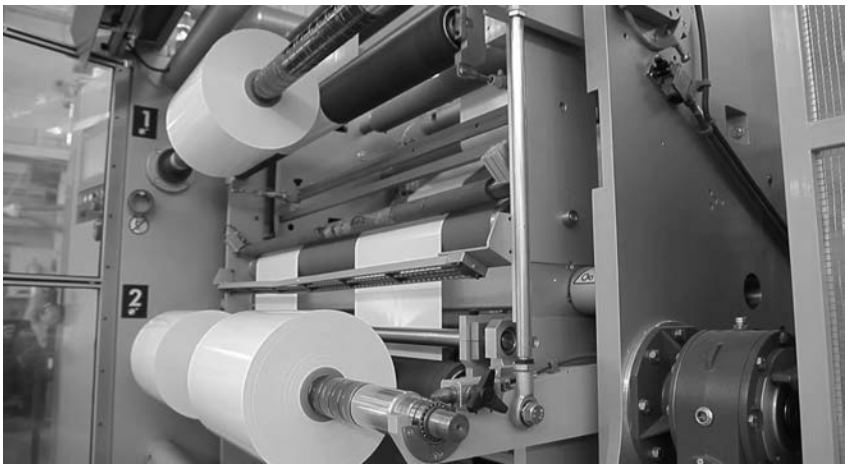
"We invented the chemistry and then created the process to make a line of plant-based polymers that are not only industrial compostable but also backyard, soil, and marine biodegradable."

MIKE PARKER, *Director of Research and Development,* Green Dot Bioplastics

Emporia, KS, home to Green Dot's headquarters.

Today, plant-based materials from Green Dot Bioplastics are found in scores of products including furniture, lawn & garden products, children's toys, automobile parts, and cell phone cases. The marine degradable bioplastics are best suited for single-use, disposable and packaging applications, such as food service ware, films, and bubble wrap, to name a few.

Green Dot Bioplastics sells a considerable portion of their product to Asia.



The company even has a full-time sales representative and manufacturing partner in Japan.

Supporting American Ag

But it all begins in American agricultural communities.

U.S. farmers produce significantly more than can be consumed domestically. For example, our country utilizes only 40 percent of the soybeans grown here.

Farmers need someone to buy the excess.

"More than 90% of the plant based feedstocks we buy come from American farms," said Mark. "We work hard to support our nation's agriculture."

The Value Add

The economics are impressive. "Take a bushel of grain that costs $3 to $4. A farmer could export it raw for 5¢ a pound. Mill it and turn it into starch or protein, and a processor might get 20¢ or 30¢ a pound," Mark calculated.

But that's still a commodity with almost no differentiation or variation. And it can be purchased anywhere in the world.

"We turn those milled materials into a highly-differentiated plastic available in only a few places globally, and we're able to sell it for $1.50 to $3.50 per pound," said Mark[.]

That's a 500–600% increase in value resulting from Green Dot Bioplastic's capital investments, chemistry expertise, polymer expertise, and numerous innovations.

Rural America's Next Engine of Growth

Better still, the economic benefits reach more than just American farmers.

Green Dot Bioplastics has three facilities, all in Kansas communities ranging in population from 700 to 26,000 people and each at least 2 hours' drive from a major airport.

Seventy-five percent of Mark's employees hold college degrees, including scientists, chemists, and engineers. Even the staff running machines on the manufacturing floor have at least 2 year degrees.

"In these communities, I'd estimate our salaries are two to three times the community average. In some cases, our employees are among the highest paid folks in town," added Mark.

These types of Ag Tech and STEM jobs help grow and support the local rural economy.

"It's also about the brain power that didn't leave and the brain power we are bringing in. Many of our rural communities are now on their third or fourth generation of brain drain, and that's worse than the money leaving," noted Mark.

One example is plant Engineering Manager, Amanda Childress, who joined the team, moving from New Mexico to put her mechanical engineering degree to work.

"The good news is, that in a small, rural community it doesn't take much to make a big difference," Mark added.

But Green Dot Bioplastic's economic contribution to rural America doesn't end there.

"More than 90% of the plant based feedstocks we buy comes from American farms. We work hard to support our nation's agriculture."

Green Dot's Remmert.

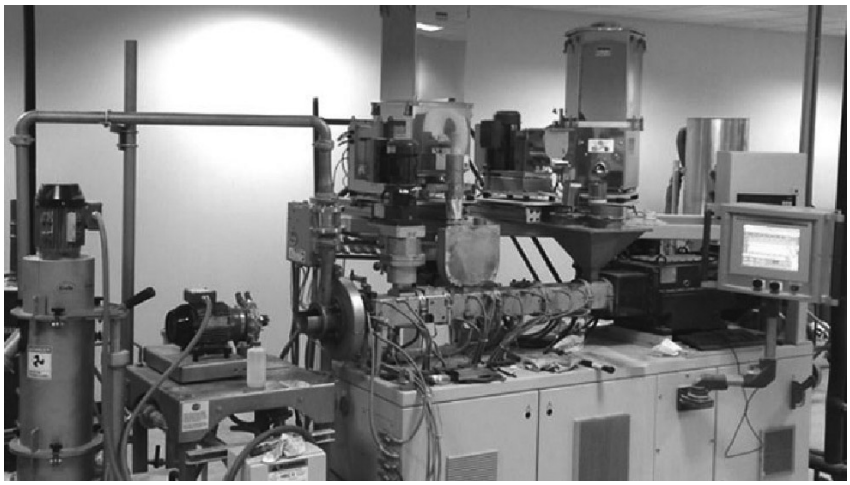
Reshoring Jobs

Over the last 30 years, substantial amounts of American manufacturing moved to China. Companies built complex, global supply chains, supported by just-in-time shipping.

"Entire industries have gone extinct in the United States, and the institutional knowledge has disappeared as well," said Mark.

Even before trade wars and the coronavirus accelerated a reversal in these trends; American companies who once relied exclusively on overseas production are seeking to return to U.S. shores.

"As a raw material maker based in the rural Midwest, U.S. companies are increasingly seeking our advice on how to make their products in the U.S.," Mark said. While Green Dot Bioplastics can't disclose specific clients, Mark noted, "We've been able to help several big, well-known companies move millions of dollars' worth of manufacturing back to the U.S."



Consider the advantages. Previously, U.S. farm products were shipped to China for production and manufacture, then returned to the U.S.

"First there's an enormous carbon footprint to all that travel. Second, imagine the shipping costs—two trips across the Pacific," Mark noted.

All in all, it took 3 months.

"Today, we make that product on Monday, it travels 100 miles down the road to our customer on Tuesday, and they go intoproduction on Wednesday," said Mark.

Three months are reduced to 3 days. The thousands of tons of carbon required for global transportation becomes a short ride by truck. And the manufacturer saves substantial shipping costs.

"This industry offers a truly unique opportunity," said Mark. "We can bring manufacturing back to rural America—creating jobs in research and development, chemistry, and engineering for areas that have suffered economically. Not only that, the industry based on our nation's existing competitive strength in sustainable agriculture—supporting farmers—while helping solve some of our greatest environmental challenges in plastic pollution and greenhouse gas emissions."

"We've been able to help several big, well-known companies move millions of dollars' worth of manufacturing back to the U.S."

Green Dot's Remmert.

Plant-Based Leaders: Hexas Biomass

Woman-Owned Startup Uses Grass to Save Forests

"Our forests are increasingly threatened by climate change, forest fires, and bark beetles and other pests."

WENDY OWENS, *CEO,* Hexas Biomass.

A forest of 20 year old pine trees and a field of giant perennial grass appear to have little in common, but once harvested, their biochemistry is actually quite similar.

Wendy Owens, CEO of Hexas Biomass Inc., founded her startup company on that insight. "We've developed varieties of a giant perennial grass that are exceptionally versatile and fast-growing and able to serve as a substitute for wood, bamboo, and fossil fuel-based raw materials," Wendy explained. "We call the varieties Xano Grass."

Cut the Grass, Leave the Trees

The idea behind Hexas grew out of Wendy's love for trees and the need to ease the industrial burden on forests globally. "When it comes to wood, we can be a supplement or total replacement," said Wendy. "That's essential as our forests are increasingly threatened by climate change, forest fires, and bark beetles and other pests."

Meanwhile the global demand for wood is growing exponentially, driving up wood costs. The USDA expects wood prices in the U.S. to rise 31–46% between now and 2050.

Hexas is working with current and potential customers to use Xano Grass fiber to produce particle board, medium density fiberboard, packaging, bioplastics, and aggregate.

When turned into a renewable fuel, Xano Grass biofuels meet the requirements of Renewable Fuels Standard (RFS) Program. EPA-approved biofuel applications of Xano Grass include biodiesel, renewable natural gas, jet fuel, heating oil, naphtha, and ethanol.

"Xano Grass produces three times more ethanol per acre than corn," said Wendy. "This means it can replace fossil fuels and allow corn to be used for food, not fuel." She added that when converted into energy pellets, Xano Grass burns as hot or even hotter than wood pellets in BTUs per pound. In addition, Hexas is also exploring its ability to be used in hydrogen production.

From Grass to Globally Recognized Furniture

When companies are considering a shift to more sustainable raw materials, like Xano Grass, they often study the impact of such a shift on their already existing manufacturing systems, fabrication processes, and bottom line.

"To upgrade to a 'more sustainable lightbulb,' companies shouldn't have to replace the entire light fixture," said Wendy. "We can deliver Xano Grass raw material as dust, chips, or fiber of any size or moisture content. And it drops right into existing manufacturing systems."

Wendy added, "We work with an international home goods company on fiberboard applications, which they plan to utilize in their furniture," said Wendy. One of Hexas' largest customers is a well-known Fortune 100 brand, with stores all around the world.

In place of wood, Xano Grass fiber is seamlessly dropped into the existing particle board production process, helping to reduce the burden on forests all around the world.

In addition to the current applications, Hexas is studying how its feedstock may be used in pulp and paper, green chemicals, textiles, building materials, and composite materials such as concrete and fiberglass. "Right now we are testing Xano Grass fiber in concrete, in order to make it lighter while enhancing its acoustic and insulative properties without losing its strength," explained Wendy.

> *"To upgrade to a 'more sustainable lightbulb,' companies shouldn't have to replace the entire light fixture. We can deliver Xano Grass raw material as dust, chips, or fiber of any size or moisture content. And it drops right into existing manufacturing systems."*
>
> Hexas' Owens.

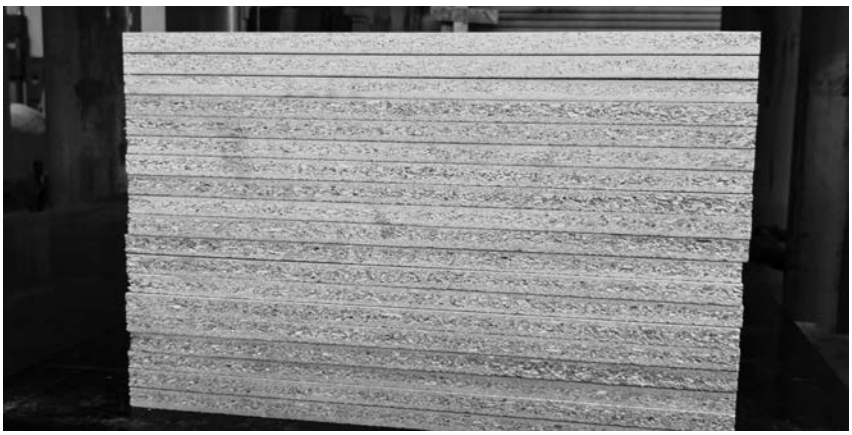
Additional Environmental Benefits

"We wanted to offer a plant-based raw material product that was both regenerative and cost effective," said Wendy. "A product that is good for fields and farmers."

Xano Grass Fiber.

In addition to reducing the pressure to harvest the world's trees, Xano Grass also improves the soil by returning nutrients to the earth, preventing soil erosion, and capturing significant amounts of carbon in the soil.

"It grows in a variety of soils—salinated, sandy, nutrient-poor, and soil that has deteriorated. It also will remediate soil by removing pollutants, including heavy metals, chemicals, and effluviant," added Wendy. "For farmers, that means it can help remediate marginal land so it can be used to produce food crops again."



Fiberboard made from Xano Grass.

Xano Grass also prevents nutrient run-off from excess fertilizer when planted along row crops. "Studies have shown that Xano Grass absorbs the excess nutrients

applied to the row crops, helping to prevent algae blooms in rivers and watersheds," added Wendy.

When a company chooses Xano Grass, Hexas goes to work contracting with local farmers to grow it, offering them long-term contracts. "From the very first year, Xano Grass offers farmers solid annual yields, 20 or more dry tons per acre. This creates a steady revenue stream for them. And Xano Grass doesn't require a lot of time in the field to support production," explained Wendy.

Importantly, Hexas will not allow cultivation that displaces crops grown for food.

"We only use marginal land, which we define as land that cannot economically support food crop production," said Wendy. But, she says, farmers are often eager to put such land to work, especially given all Xano Grass' environmental benefits.

Strengthening Local Economies

Just like in real estate, biomass production comes down to location, location, location because transporting low density biomass long distances doesn't make economic sense.

"Shipping any kind of biomass is about time and space," Wendy said.

With that limitation in mind, Hexas strives to enlist farmers within 60 miles of a customer's manufacturing plant.

The good news is that Xano Grass thrives in a broad range of climates.

Unforeseen benefits have come from these transportation challenges. "It means that our customers are supporting their local farmers, and that builds important relationships and keeps revenue within those local communities," explained Wendy.

Hexas is looking to strengthen this idea by working with community stakeholders, like the Yuba Community College District in northern California.

They are hoping to train the next generation of agronomists, biomass processors, as well as many others who can build careers in the new bioeconomy.

Choosing an Accelerator

Like many start-ups, Wendy sought the support of a start-up accelerator, researching a handful before identifying which was the best fit for Hexas. Wendy chose Cascadia CleanTech Accelerator from the CleanTech Alliance and Vertue Labs and had an incredible experience learning with them.

"The program not only examined our ideas at the macro level, but dug deep into the technological and economic feasibility," said Wendy. "The networking was essential as well. We met mentors that we're still working with today."

"Our customers are supporting their local farmers, and that builds important relationships and keeps revenue within those local communities."
Hexas' Owens.

Xano Grass sprouts.

Hexas won the Standout Company Award in 2019.

"Even though this is my fourth start-up, there's always room to learn—so we feel extremely fortunate for the experience," she added.

Based on her experience, Wendy recommends participating in an accelerator with a proven track record. She suggests looking into the companies that have previously participated in the accelerator and meeting with a few before making any important decisions.

"Review the curriculum to make sure it meets your needs and understand the time commitment," Wendy adds. "Accelerators can consume your entire day, leaving founders to run their business at night."

Ms. Owens recommends avoiding any accelerator that requests large up-front fees and suggests that founders think very carefully about whether or not they are willing to give up equity in their company in exchange for funding and participation.

Many accelerators request equity as a condition of joining their programs.

Wendy purposely chose an accelerator that did not require Hexas to give up any equity. "It was too early in our development to understand how that would impact our cap table and the company's valuation further down the line," she added.

Federal Programs and Support

Policymakers in Washington have an important role to play when it comes to ensuring a competitive plant-based products industry, explains Wendy, singling out the USDA BioPreferred Program for special praise. She suggests that the Federal Government can and should do more by promoting non-food bioenergy crops as viable substitutes for petroleum-based products and first-generation bioenergy crops like corn.

Wendy believes, "Washington needs to accentuate and accelerate the bioeconomy through policies and regulations that support its expansion in rural communities in particular."

She points to the addition of bioeconomy-based NAICS codes as a very important example of where a relatively simple policy change could give a real boost to the industry.

"There is no specific NAICS code for plant-based products or their raw material components. There's no code for biomaterials or bioenergy," explained Wendy. Wendy went on to say that without such codes, the Federal Government cannot effectively measure these industries.

While the Federal Government has an essential role to play, Wendy says consumers will ultimately drive the market. Research from the Plant Based Products Council (PBPC) shows that 54% of U.S. consumers view these types of products favorably and more than half are more likely to purchase plant-based products in the next 3 months.

"Companies who can deliver sustainable products will find an eager market of more than 136 million U.S. customers," said Ms. Owens.

"Companies who can deliver sustainable products will find an eager market of more than 136 million U.S. customers."

Hexas' Owens.

Plant Based Leaders: Novamont

Award Winning B-Corp and Compost Champion Creates Environmental Solutions

"We can all help reduce the burden on landfills and lower methane emissions by ensuring food waste instead becomes compost."

PAUL DARBY, *VP Marketing,* Novamont.

Food waste is the single largest input to landfills.

In fact, 75% of our nation's food waste ends up in incinerators and landfills.

Once discarded in a landfill, food waste decomposes and contributes directly to the emission of methane (CH_4), a greenhouse gas. Methane is "more than 25 times as potent as carbon dioxide at trapping heat in the atmosphere," reports the U.S. Environmental Protection Agency (EPA).

EPA notes that landfills are "the third-largest man-made source of CH_4 emissions in the United States."

"We can all help reduce the burden on landfills and lower methane emissions by ensuring food waste instead becomes compost," explained Paul Darby of Novamont, which is a member of the Plant Based Products Council (PBPC).

Compostable bags are one essential component to addressing rising greenhouse gas emissions.

Such bags provide consumers an easy and hygienic way to collect their food scraps for composting.

"Two of America's top ten largest grocery chains offer such compostable bags—one provides them to shoppers as fresh produce bags for use in-store and the other as food waste bags for use at home. Both are made in the USA from our MATER–BI. For every 1.5 kg of food waste collected and composted in this bag, 2.6 kg of CO_2 equivalent is saved, avoiding methane production in landfills," added Darby.

Novamont's MATER–BI is a compostable biopolymer, derived from plants and biodegradable materials.

Food Waste for Healthier Soils

But composting doesn't simply reduce greenhouse gas emissions. With the help of farmers and gardeners, composting's benefits reach much further.

Compost captures nutrients and minerals in the food scraps and returns them to the soil. The rich organic matter benefits soil health through structural amelioration, increased water holding capacity, and greater water infiltration capabilities.

And using soil-enriching compost helps prevent erosion of valuable topsoil.

A Composting Infrastructure Case Study

A Novamont-assisted project illustrates one way to achieve these important goals.

"Milan is Italy's second largest city, with more than one million residents," explained Darby.

In 2012, the city introduced a door-to-door organic waste collection system utilizing compostable bags made from Novamont's MATER–BI biopolymers.

The company provided a starter kit of 25 free bags for every resident and supported a city-wide educational campaign.

Italian legislation also requires all grocery store shopping and produce bags to be compostable which helps avoid plastic bag contamination at compost and anaerobic digestion facilities, all while creating another source of easy-to-find bags for collecting food waste at home.

For example, every time shoppers fill a bag with fresh fruit and vegetables, they bring home a new bag that will contribute to this important environmental effort.

The bags are then used by shoppers to line their home from kitchen counter food scrap bins, making disposal of apple cores, banana peels, and other food scraps quick, clean, and easy through the city's curbside collection system.

> *"Today, Milan collects* ***over 85% of its residential organic food waste for composting*** *and anaerobic digestion with the easy access to compostable bags playing a pivotal role in participation rates while avoiding contamination with conventional plastic bags."*
>
> Novamont's Darby.

"We gave consumers the tools they need to divert food waste landfill and incineration," added Darby.

Milan's Exceptional Results Spread Across Europe

By June of 2014, the program reached 100% citywide participation, collecting 50% of resident's organic waste, diverting it from local landfills, and delivering it to composting facilities plus anaerobic digestion facilities with on-site post-composting.

That impressive result both extends the life of local landfills and dramatically reduces methane emissions.

"Novamont worked closely with the city and retailers to create and share messages about how to use the compostable bags, making sure consumers knew to put their cores and peels back in the bag for composting and curbside pick-up," added Darby.

Italy, France, Spain, and Austria all require grocery store loose produce bags to be compostable.

U.S. Policymakers Study Milan's Success

"We also welcome American policymakers and other influencers for educational trips to see the success we've had in Milan."

"For example, in 2019 we worked closely with the Natural Resources Defense Council (NRDC) to help coordinate a trip with city officials from Baltimore, Columbus, Denver, Oakland, and Phoenix," said Darby.

A core tenet of NRDC's Food Matters project is to foster a food waste knowledge sharing network among cities.

For 4 days, participants had the chance to see how the City of Milan, a hub for food systems work, has taken a systems approach to make its food system more sustainable.

"Participants met with governmental actors, NGO, and business innovators and built connections across cities and countries," explained Darby. "And we would welcome visits from other interested policymakers in the future."

"Our goal was to highlight different approaches that U.S. cities could learn from," added Darby.

Today in the U.S., for example, the City of San Francisco allows only paper or certified compostable produce bags in their grocery stores. The compostable produce bags can be re-used for food scrap collection for the city's curbside organics program.

But the paper bags are not ideal for food scrap collection, due to the high water content of most foods. They instead can be recycled.

Novamont's educational campaign for policymakers focused on city-level officials, because until recently, composting policies and related infrastructure projects were generally local, municipal issues.

But that is about to change.

Congress Considers Composting

Novamont, as part of the Plant Based Products Council, helped launch the U.S. Composting Infrastructure Coalition. The Coalition supports the COMPOST Act, which establishes a USDA-led Federal grant and loan guarantee program to help fund composting infrastructure. Other members of and advisors to the coalition include the NRDC, U.S. Green Building Council, National Waste & Recycling Association, U.S. Composting Council, Biodegradable Products Institute, and the Institute for Local Self-Reliance, and the American Sustainable Business Council.

"Our Goal is to launch products that can be conceived as environmental solutions."

Novamont's Darby.

"We couldn't be prouder to be part of PBPC and their legislative push to see the bill enacted into law," added Darby.

"More than 80% of Americans do not have access to food scrap composting. This bill can help provide funds to deliver that critical infrastructure. The result will be improved air, soil, and water quality across the nation."

Novamont cares about these issues because it is so close to U.S. Businesses and customers.

From the U.S. to Italy and Back Again

For over 30 years, Novamont's visionary founders have taken an integrated approach to chemistry and agriculture.

MATER–B Resin Pellets.

Today, the company is a global leader in bioplastics and biobased products development and production, with over 1,800 patents, primarily in biopolymers and biochemicals.

"Our goal is to launch products that are conceived as environmental solutions," explained Darby.

MATER–BI resins are made in part by utilizing a patented technology from San Diego-based Genomatica. That technological process converts plant-based sugars to the renewable green chemical known as 1,4 butanediol (or Bio-BDO), utilizing industrial-strength engineering of microorganisms to perform the chemistry reliably at commercial scale.

The company's products reach far beyond bags, all the way to the beginning of the plant-based value chain. For example, Novamont produces MATER–BI resins used to manufacture agricultural mulch film.

This substitute for conventional plastic mulch is used by farmers the world over to protect crops from insects and disease. It also helps eliminate weeds, lining the ground next to row crops and vegetables.

"Our mulch film helps farmers improve production and efficiency. Then, at the end of the growing season, our mulch can simply be plowed back into the soil where it will biodegrade," explained Darby.

MATER–BI is also used for food service applications which include a coating for paper cups and packaging to help provide water and grease proof resistance.

A Model for Revitalizing U.S. Manufacturing

"We understand the importance of supporting local manufacturing. We work closely with a number of U.S.-based manufacturers, and we want to promote the growth of this industry in the U.S.," said Darby. "We see opportunities to invest further in the U.S., but we need the help of policymakers to shape the business environment and boost this growing industry."

After all, Novamont has already shown how its economic revitalization model succeeded in Italy.

In preparing to develop their four key production facilities including the one tied to the partnership with Genomatica, Novamont identified previous manufacturing sites that were no longer competitive, seeking an opportunity to redevelop idle infrastructure. While such facilities were once drivers of the local industrial economy, Novamont converted these sites into 21st century biorefineries and production facilities on the very cutting edge of chemistry and manufacturing.

Refurbishing unused buildings and fermentation equipment combined with new equipment, the Bio-BDO facility created 300 local construction jobs and today 70 people are employed at the plant, delivering high-quality jobs in the manufacturing sector.

In fact, the regeneration of local areas through the rehabilitation of abandoned production sites is a primary company principle, aligned with its B Corp ethos.

B-Corp Status

The global network B Lab has nominated Novamont a B-Corp 'Best for the World 2021' company, recognizing its exceptional environmental performance, which is in the top 5% of all B-Corp companies worldwide.

Certified by the independent body B Lab, the Benefit Corporation designation establishes that in addition to generating profit for shareholders, B-Corp companies also create a positive impact on society and the environment, thus building a more inclusive and sustainable economy.

"Benefit Corporations meet the highest standards of verified social and environmental performance, public transparency, and legal accountability to balance profit and purpose," explained Darby.

"We work closely with a number of U.S.-based manufacturers and we want to promote the growth of this industry in the U.S. We see opportunities to invest in the U.S. but need the help of U.S. policymakers."

Novamont's Darby.

Plant Based Leaders: Virent

Innovative Company Recreates Petrochemicals & Fuels with Sustainable Plant-Based Biomass

DAVE KETTNER, PRESIDENT & GENERAL COUNSEL OF VIRENT, INC.

Today's global economy relies on hydrocarbons in the form of natural gas and oil. Those resources began as organic matter—decaying plants and animals, subjected to intense geological pressure over millions of years.

Now, in an effort to reduce our reliance on oil and natural gas, that geological process has been reimagined and recreated by Virent scientists, who have substituted sustainable biomass for ancient organic matter, creating a new source of green chemicals and biofuels.

Yet at the molecular level, these new and renewable products are identical to their petroleum-derived counterparts. That means Virent's materials are "drop-ins"—they can be used in the current manufacturing and energy infrastructure and production plants without changes to existing supply chains.

A Simple Explanation for a Complex Process

Ralph Lerner explained the process from their Madison, Wisconsin facility. He serves as Senior Vice President of Commercial Development at Virent.

"Fossil fuels are comprised of carbon and hydrogen."

"Meanwhile, renewable feedstocks are made up of carbon, hydrogen, and oxygen. To create renewable hydrocarbons, you need to remove that oxygen. That's what our technology achieves," said Ralph.

Dave Kettner, President of Virent, added, "And while oil and natural gas are created over geological time frames, our process is done rapidly. Better still, our primary byproduct is water, rather than the carbon and methane pollutants produced by extracting and processing oil and natural gas."

That result? Dramatically lower carbon footprints for companies choosing Virent's plant-based green fuels and chemicals.

From Plant-Based Bio Polyesters to Sportswear, Clothing and Beverage Bottles

"Polyester is one of the biggest and fastest-growing material sectors—used in clothing, textiles, plastic films and packaging, and plastic bottles, among many other things," explained Ralph.

Polyester today is made from a petroleum-based precursor chemical known as paraxylene.

Virent has created an alternative source of paraxylene, made from sustainable agricultural feedstocks and, once commercially available, lignocellulosic materials from wood waste and the stalks of corn, sugar cane, and other materials. Because it is the same molecule, albeit biobased, Virent's renewable version can be seamlessly substituted for its petroleum-based counterpart to make biopolyesters.

Manufacturers of all types are taking notice.

"We've spoken to numerous companies in many different end use areas that are interested in biopolyesters. Many want to make more sustainable products, others are working to reduce greenhouse gas emissions," said Ralph. "Our products help companies achieve both."

Virent believes it can help achieve those goals.

A Life Cycle Analysis study conducted with a third party found a greater-than 50% reduction in the CO_2 footprint of Virent's biobased paraxylene when compared to its petroleum-based counterpart.

PET is the acronym for the materials that make common petroleum-based plastic bottles.

In 2015, in partnership with Coca-Cola, Virent created the world's first demonstration-scale production of a plastic bottle made entirely from plant-based paraxylene. The sustainable chemical was dropped into an existing PET production process, spotlighting just how easy such a transition could be, according to the Virent team.

"And these plant-based bottles are completely recyclable through existing waste management systems," added Ralph.

RALPH LERNER, *Senior Vice President of Commercial Development,* Virent, Inc.

We've spoken to numerous companies interested in bio-polyesters. Many want to make more sustainable products, others are working to reduce greenhouse gas emissions. Our products help companies achieve both.

Virent's Lerner.

Essential Feedstock & Product Flexibility

Perhaps most impressively, Virent has a growing portfolio of green chemicals.

Hard plastics used in applications such as electronics, laptops, motorcycle helmets, and safety goggles, for example also start with chemical raw materials that include benzene.

"Benzene is another petrochemical we've re-created from plant feedstocks. It's commonly converted into advanced engineered plastics, detergents, packaging materials, and various other applications," noted Ralph.

"Another interesting market is construction materials—think about petroleum-based products like ABS and polycarbonate, for applications including plastic pipes and building windows as examples. These products currently use benzene as one of the raw materials and could also ultimately be based on plant-based chemicals," noted Dave.

"When made from Virent's renewable, plant-based chemicals, these long-lasting products actually become carbon sinks. After all, they are made from atmospheric carbon removed from the environment during photosynthesis," explains Dave.

"We can also make plant-based toluene, which has solvent applications, or which can be a building block for other specialty chemicals," Ralph notes.

The mix of scientific names may not mean much to non-chemistry majors, but the technology's flexibility is the important takeaway.

"A single commercial plant will be able to make all three green compounds from a wide diversity of feedstocks," said Dave. "To make our green chemicals, our technology can use carbohydrates from corn, beets, sugar cane, corn stover, ag waste, and multiple types of woody biomass, including pine, ash, and others. For a commercial scale plant, we are focused on feedstocks that are commercially available today, while looking towards cellulosic feedstocks when they are available."

The U.S. today has the world's most efficient agricultural sector that meets U.S. demand and also exports products around the world. Agricultural productivity is continuing to increase and companies like Virent are providing new market and growth opportunities to U.S. agricultural producers.

Consumer Demand Drives Sustainability

Of course, the Virent name won't appear to consumers on store shelves. The company sits near the beginning of the manufacturing process, with plans to work with companies in the chemical industry to develop its plant-based chemicals and establish a supply chain.

But the consumer market is key.

"Getting consumers and the consumer brand companies invested in sustainability issues is essential to creating a healthy market for renewable products," said Dave. "As more consumers speak up—calling for responsible corporate action and better products—we see interest at companies growing."

"Right now, our marketing focus is on working with brands and end users to convey the potential of biobased materials and also to produce demonstration products. It's a chance to show them that we have the technology. And consumer-facing brands have been quite interested," said Ralph.

Virent is actively working on the scale-up and commercialization of its technology. Longer term, the company also has plans for licensing the technology so that others can help make a positive difference towards a more sustainable environment.

"We're actively pursuing all avenues," said Dave.

Virent is one of the few that design green chemicals with catalysts instead of microorganisms.

Virent's Kettner.

Government's Role

"Our industry is 5 or 10 years old and we're scaling up a whole new industry from scratch," explained Dave. "Of course, we're simultaneously competing with oil and petrochemicals—sectors that have decades of investment and optimization."

The first refineries were built over 100 years ago, and petrochemicals date back to the 1930s.

"Biobased products are increasingly competitive on price, but it's tough to beat someone with a century-long head start. And that's where government policy and tax incentives could really help," he said.

More on the Science

Virent is not the only company making green chemicals. But they're one of the few that design these essential building blocks with catalysts instead of microorganisms.

Catalysts are inanimate. Microbes are, of course, living creatures.

"Scientists have engineered yeasts and other microorganisms to eat the sugar from biomass feedstocks and then excrete the chemical compound of interest. That is how ethanol is commonly manufactured," explains Dave.

"But as living creatures, the microorganisms also need to grow and replicate, and so they consume some of the sugars for that purpose, reducing the yield of the final product."

Most microorganisms eat only one or a couple types of sugar. They can be sensitive creatures, too—to temperature, contamination, and competition.

"Our catalysts don't care about any of those issues and don't consume a drop for other purposes, so they don't reduce yield," added Dave. "They conduct their proscribed chemical reactions and are ready to go another round. Better still, we've designed our catalysts to work with all types of sugars and other secondary compounds, which provides us feedstock flexibility so that we can co-locate our production facilities near feedstock inputs from nearly every part of the U.S. and around the world."

Greenhouse Gas Emissions Overview

PBPC Plant Based Products Council

The growth of greenhouse gas emissions in our atmosphere is one of the biggest environmental imperatives we face today. Traditional plastics are made using fossil fuels that further contribute greenhouse gas emissions to our ecosystem.

Plant-based alternatives can help reduce greenhouse gas emissions because they come from a renewable source of carbon and can avoid contributing to landfill emissions when properly disposed of.

The carbon used to create plant-based materials comes directly from the atmosphere in the form of CO_2, the primary greenhouse gas emitted by human activities

- Unlike materials derived from fossil fuels, **feedstocks from plant-based materials remove CO_2 from the atmosphere** during their growing phase
- The CO_2 taken up by plants during their growing phase is **used to build these plant-based products** and sequestered in their materials during their time as a useful consumer product.

By 2030,

if two-thirds of conventional plastics around the globe were replaced by plant-based alternatives, the reduction of emissions would be equivalent to removing from the atmosphere the annual energy use of over 80 million homes

Plant-based materials used in food service applications can significantly reduce landfill emissions by diverting food and plastic waste from landfills.

- Landfills are the **third-largest source of methane emissions.**
- Food waste, **which is 22% of landfilled municipal waste,** is a large contributor to landfill methane emissions.
- Unlike traditional plastics, when many plant-based materials are done with their useful life, they can be **sent to composting facilities along with associated food waste,** where facilities then **produce soil-enriching compost instead of harmful methane emissions from landfills.**

Through plant-based products – made from renewable sources like bamboo, corn, hemp, potato, sugarcane, soy, and more – we can help lower greenhouse gas emissions.

PBPC is working to guide the global economy toward more sustainable and responsible consumer products and packaging through greater use of plant-based materials.

Learn More at pbpc.com

Municipal Waste Overview

PBPC Plant Based Products Council

America is facing a waste management crisis. Over 267 million tons of municipal solid waste are produced each year in the U.S., and over half of the waste produced annually ends up in landfills. That is over 850 pounds of municipal solid waste landfilled per capita every year in the U.S.

Plant-based products present a clear opportunity to address waste management challenges and help ensure a more sustainable planet.

Since the rise of plastic as a widespread consumer material in the late 1950s, more than 6.9 billion tons of plastic waste have been generated.

However:

- Only 9% of plastic waste has been recycled.
- 79% ends up in either a landfill or the environment.
- Since 2000, the percent of total annual municipal solid waste recycled out of all municipal solid waste generated has only risen over three percent.
- It is estimated that over 26 million tons of plastic is added to landfills across the country each year

By 2030,

if two-thirds of conventional plastics around the globe were replaced by plant-based alternatives, the reduction of emissions would be equivalent to removing from the atmosphere the annual energy use of over 80 million homes.

Landfills are the third-largest source of methane emissions, emitting 107.7 million metric tons of CH_4 and 16.4% of the U.S.' total annual output.

Plant-based materials can help reduce landfill waste and landfill methane emissions because they offer a wide range of disposal opportunities, such as recyclability and compostability, while some are even biodegradable.

Plant-based materials offer a solution to help reduce the amount of plastic and food waste in our country's landfills.

PBPC is working to guide the global economy toward more sustainable and responsible consumer products and packaging through greater use of plant-based materials.

Learn More at pbpc.com

Soil Health Overview

PBPC Plant Based Products Council

The health of our soil in America is declining. Currently, our soil is losing its nutrients, structure, and organic matter, all of which are harmful to the agriculture community, plants, the environment, and even our water. Healthy soil is the foundation of food, fuel, fiber, and all industries reliant on traditionally abundant renewable biomass that is tied to America's past, present, and future success.

Compostable plant-based materials represent a powerful tool to improve the health of soil. When used in food packaging and service ware, these compostable materials have the ability to increase the total amount of compost generated from not only their mass, but also the mass of accompanying food waste disposed with them.

Compost is a valuable soil amendment that can mend our nation's depleted soil resources, benefitting:

Farmers & Ranchers

Homeowners

Landscape managers

Urban agriculturalists

Plant-based alternatives can help create many benefits for our currently declining soil health.

U.S. government agencies have long recognized the health benefits of compost for soil.

- EPA has suggested that compost can enrich soil, reduce the need for chemical fertilizers, encourage the production of bacteria and fungi that can break down organic matter to create humus, reduce methane emissions from landfills, and lower our carbon footprint.
- USDA has explained that compost can enhance rainfall penetration which reduces water runoff and soil erosion, improve the soil, and enhance beneficial microbes that help reduce plant diseases and pests.

Compost can help improve the carbon-sequestration abilities of our soils.

- Traditional soils store incredible amounts of carbon and adding compost to soil can help increase carbon storage capacities, as well as sequestration abilities, thus offsetting CO_2 emissions.

PBPC is working to guide the global economy toward more sustainable and responsible consumer products and packaging through greater use of plant-based materials.

Learn More at pbpc.com

The CHAIRMAN. Thank you, Ms. Bowman.

Next, we have Ms. Stolzenburg. Please begin when you are ready.

STATEMENT OF NAN C. STOLZENBURG, PRINCIPAL PLANNER AND FOUNDER, COMMUNITY PLANNING & ENVIRONMENTAL ASSOCIATES, BERNE, NY

Ms. STOLZENBURG. Thank you. Good morning, everyone. My name is Nan Stolzenburg, and I am a community and land use planning consultant with almost 30 years of experience working with rural communities. Today, I am not representing any specific agency or organization, but wish to represent the many rural com-

munities I have experienced working with on the topic of siting renewable energy facilities.

To grow the renewable economy, we must address the challenges relating to siting of renewable energy facilities in rural areas. I will focus specifically on solar facilities, and how the lack of land use planning, information sharing, community involvement, and forethought relating to siting creates barriers to the renewable economy.

There certainly is recognition that we need to develop renewable energy resources to meet climate change challenges, but at the same time, our efforts to meet that challenge should not diminish agricultural production, or adversely impact our rural communities or our environment. Because facility siting is currently industry-driven, local communities usually are reactive to a specific proposal. Few have done or even know how to do any proactive planning to identify and locate appropriate sites that would work for all. Few communities have the resources to do comprehensive analysis with a lot of public input to identify acceptable locations for siting. Coupled with real or perceived lack of tangible benefits for host communities, poor siting that removes prime farmland soils, prevents other desired rural land use opportunities, and adversely affects other aspects of the rural economy causes friction and fosters negative attitudes towards renewable energy. Rural communities often resent their losses that benefit urban areas. Development of large-scale solar facilities are often at cross purposes to other stated public goals, such as protecting prime farmland soils for agriculture, or for woodlands to promote carbon sequestration.

Although some facility siting guidance and planning tools exist, they often remain unreachable for our small communities due to lack of coordination, staff, communication, and regional planning. But these challenges can be overcome with good planning.

What does good planning mean? Good planning involves identifying both natural resources and critical local features that need to be protected together with identifying locations that have the right conditions for a renewable facility. Models exist for this natural resource-based type of planning, but they are not commonly or easily applied. It would be a planning process carried out at the local level to involve local officials and community members. This would build both acceptance and more assurance for approval processes. It would include development of much-needed site selection systems that can be applied broadly but fine-tuned locally with incentives and required performance standards. It should prioritize lands that are distressed or no longer usable for other purposes, and identify sites consistent with other local goals and regional goals. Suburban and urban locations should receive a lot more attention as locations for renewable energy facilities, especially related to rooftop, parking lot, and building integrated systems and with incentives to support them. Prime agricultural soils and forestlands should be protected.

I urge Congress to consider establishing programs and policies that address these problems. Some of these solutions could include to promote local planning and provide financial resources that assist communities in assessing their renewable energy capacity, and that involves local residents in a meaningful way to apply criteria,

identify appropriate sites, and balance a variety of needs. We can collate existing planning models in renewable energy siting research to establish siting criteria, and then incentivize them or require them in certain instances. We should require or incentivize use of dual-use, that is, like agrivoltaics, in renewable energy siting and involve the farm community early so that they can also benefit from these renewable facilities. Agrivoltaics can couple food protection, raising and use of native grasses and pollinator friendly plants that meshes agricultural entrepreneurship with renewable development. We need to promote truly community-scaled facilities that provide more benefits locally and that are perceived to be beneficial to the rural community. I urge Congress to establish national policies related to siting of renewable energy facilities, and to enhance local planning tools that consider the complex and multi-faceted experiences, expectations, and values of our rural residents. We should be looking across states and carefully identifying and prioritizing suitable locations that balance smart land use planning in a way that also develops renewable energy resources.

It is my hope that by taking these steps, that the renewable energy economy will flourish. Thank you very much.

[The prepared statement of Ms. Stolzenburg follows:]

PREPARED STATEMENT OF NAN C. STOLZENBURG, PRINCIPAL PLANNER AND FOUNDER, COMMUNITY PLANNING & ENVIRONMENTAL ASSOCIATES, BERNE, NY

Good morning and thank you for the invitation to participate in today's hearing. My name is Nan Stolzenburg, and I am owner of, and Principal Planner for the consulting firm, Community Planning & Environmental Associates (CP&EA) located near Albany, NY. I have provided land use and environmental planning consulting to small and rural communities throughout New York State for over 28 years. I am certified as a Planner (AICP) and an Environmental Planner (CEP) by the American Planning Association.

My work is focused exclusively on the planning needs of small and rural communities, and we have been principal consultants on numerous county-level and town-level agricultural and farmland protection planning efforts across the state. I have also worked with many rural communities on issues related to renewable energy land uses. My comments stem from my experiences from being retained by communities specifically to address renewable energy land uses at the local level through Town comprehensive plans, open space plans, natural resource inventories, and local land use regulations. Also, my personal experience as a member of a dairy farm family and a resident of a very rural area, offers me an additional, first-hand experience to share.

I am honored to speak to you today. I feel it is particularly important to convey to you one aspect of renewable energy development and it is an issue that challenges movement towards a more positive renewable energy economy. That issue is the siting of renewable energy facilities, specifically solar facilities, and the local perspective on such facilities. As my experiences attest, this topic needs much more attention. This topic is not only relevant to the broader renewable economy, but to agriculture. As the industry moves towards large-scale solar development, rural communities and their local policies can and do affect farmers needs or desires to use their farmlands for renewable energy development. Creative opportunities to promote renewable energy, multi-use farming, and build community exist, but are generally not taken advantage of. Solar developers economic decisions are driving the system, which typically leads to friction with rural host communities.

My perspective is shaped from experiences in New York. I recognize that the situation seen here may not be the case in all states. The key point I wish to convey is that a general lack of planning, coordination, information sharing, community involvement, and forethought related to siting of renewable facilities in rural areas has created barriers to a broader renewable economy and many missed opportunities. Lack of proactive planning for siting and site layout of these facilities coupled with the solar industry solely at the helm of site selection has had adverse impacts.

These include the removal of valuable farmland and forestland, adverse impacts to rural character—one of the largest economic assets a rural community has, and promotion of negative attitudes towards renewable energy. The lack of tangible benefits received by host communities, taxation issues, and growing resentment that these facilities are imposed on rural communities to benefit urban communities are also on the minds of many rural residents and local officials.

There certainly is a recognition in many rural communities that we need to move assertively to develop renewable energy resources to meet the challenges posed by climate change. But our efforts to meet that challenge should not diminish agricultural production, or adversely impact our farm communities, or our environment. I do not accept the premise that our renewable energy economy must come no matter its cost to our communities and environment. As a professional land use planner, I know there are indeed steps that can and should be taken to address this.

Solar facilities (as well as wind and biofuel) are often the largest built, non-farming feature in a rural community's landscape. These are major land uses built at a scale and intensity in stark contrast to other uses. Facilities are getting larger, not smaller. The current acceleration to develop renewables revolves around economics and economies of scale, and thus site selection gives little thought to the very features most highly valued in rural communities. Universally, those highly valued features revolve around rural character, agriculture, open spaces, and clean environments. At its core, the current direction focusing on large-scale renewables is seen as inconsistent with what these communities are all about. A failure to address this is a barrier to an expanded renewable economy.

These barriers often result in prohibitive local regulations, more rural/urban divisions and lost opportunities for farmers. Not surprisingly, new, large-scale renewable energy facilities fosters 'NIMBY' or "Not In My Backyard" attitudes, and thus stymies public support.

Rural communities are generally unprepared to address large-scale renewable facilities. They often have no staff support, rely on volunteer planning boards that often have little information about options they could incorporate into an application to promote best management and siting practices. They are not skilled in the environmental review of such facilities and lack resources and tools to evaluate and incorporate renewable energy into their local land use decision making. We need to empower our communities to overcome these weaknesses.

More planning is needed to guide solar facility siting. Few states and even fewer local municipalities have actually gone through a concerted planning process to identify locations that would be acceptable and suitable for renewable facilities.

Good planning would involve identifying both natural resources and critical local features that need to be protected and identifying locations that have the right conditions for the renewable facility, such as proximity to transmission lines. Through use of Geographic Information System technology, these criteria for siting solar and other renewables can be easily applied and mapped. Communities could collectively make choices about where they can accept such facilities. Local policies can be fashioned to facilitate this. Such planning would give both renewable energy developers and local communities guidance as to where to focus efforts and this will lead to more efficient and better approval outcomes. It would eliminate the perspective that renewable facilities are being 'foisted' on them that benefit others.

There are some examples of this type of planning: For example, in Kentucky, a "solar siting potential" map has been developed that can be used to help local communities plan for, instead of simply react to, renewable facilities. In other places, land trusts and environmental organizations have stepped in to fill that same planning need with siting guidelines and/or mapping tools. For instance, the Maine Farmland Trust, Scenic Hudson (in NY),[1] the American Farmland Trust, and the Chesapeake Conservancy in Maryland have all developed guidelines or GIS-based planning tools to help foster good facility siting and planning. Also, many solar developers publish their own siting guidelines (Such as the Solar Energy Industries Association, or SEIA). The U.S. Department of Energy, Solar Energy Technology Office (SETO)[2] has been conducting research into best management practices for solar siting and has many good resources.

All these are good tools with good information that could be helpful. A significant issue is that these tools usually do not trickle down to the local level where the actual renewable development is taking place. That reflects a lack of coordination, communication, and regional planning to address these issues.

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[1] *https://www.scenichudson.org/our-work/climate/renewable-energy/welcome-to-scenic-hudsons-solar-mapping-tool/*.

[2] *https://www.energy.gov/eere/solar/solar-energy-technologies-office*.

In order to both avoid and mitigate negative impacts and to build acceptance, planning processes need to take place at the local level to involve local officials and community members. As stated in a 2017 report *Accelerating Large-Scale Wind and Solar Energy in New York: Principals and Recommendations*[3] "communities need tools and resources, such as comprehensive planning and zoning ordinances, and expertise in how to use them, to be effective partners in the renewables development process." And that is simply not happening. As a result, the positive opportunities associated with renewables are greatly diminished.

In New York State at least, a variety of siting guidelines have been produced by state agencies and organizations, but there remains little coordinated, state-wide forethought into considering impacts to farmland, food systems, farmers & farm communities. While multiple siting guidelines exist and offer recommendations, there are still no special protection of prime agricultural soils and in many cases, forested areas. Clearcutting of large swaths of forest land, which is happening when solar is developed, is especially difficult for rural communities to accept.

Development of solar facilities are often at cross purposes to other stated public goals. For instance, prime farmland soils are often lost to agricultural production when it is more profitable to farm the sun than food. Farmers that rely on rented farmland for their operations have lost access to those fields which have been converted to solar use. This loss can disrupt farm viability. When rented farmland is slated for solar development, the farmer loses ability to implement whole-farm nutrient management plans for example. Loss of leased farmlands decreases the number of farms, which will also affect farm suppliers, services, and the regional economy. In our current farm economy, it is a disturbing trend that it is more economically beneficial for farmers to host solar facilities than farm that land.

Right now, because developers propose the sites and government regulators only react to proposals, it is site developers that are making the choices about where these facilities get located. Flat, accessible land is, unfortunately, desirable for both farming and renewable energy and so this friction often enters the review process from the very beginning.

Local communities, often referred to as 'host communities' more often than not in my experience have no say in whether they want to host these facilities, and do not often feel like they receive any benefits. Resentment that builds due to having to accept adverse impacts to their landscape, environment and community with no local, tangible benefits contribute to the rural/urban divide.

This absence of planning and proactive involvement of local communities often places significant barriers to renewable energy development. Legitimate concerns should be taken into consideration in the renewable economy. Planning that involves local officials, farmers and residents is a pressing need that is currently unsupported. I strongly advocate for government to take a greater role in guiding and incentivizing facility siting and providing standard protocols, methods, and expectations. We should be looking across states, and carefully identifying and prioritizing suitable locations that balances smart land use planning that preserve what is important to rural communities and the need to develop renewable energy resources.

Governments should consider creating a potential site hierarchy system, with incentives and a faster and easier approval process for sites deemed best suited for such facilities. There should be policies and requirements in place that emphasize prioritizing lands that are distressed and no longer useful for other purposes. Suburban and urban locations should receive a lot more attention so that development of rooftop solar and building integrated solar for residential and commercial buildings is an equal part of the solution. At the same time, prime agricultural soils and other important agricultural resources should be protected during the siting and application review process. This is especially important in the northeastern United States which has land resources and water to support farming in ways western and midwestern communities do not.

Government should not shy away from local community input. Instead, use community input in a planning process to help inform the selection of potential sites so that local communities have a voice in that selection and simply don't have sites imposed on them by developers and regulators.

Our policies should consider encouraging more smaller solar energy facilities that distribute the power generated locally. Communities in general view these facilities more favorably because they make a difference locally and there are tangible benefits that could outweigh disadvantages. Smaller facilities will likely have smaller footprints and lower impacts to agriculture lands, rural character, and the environment.

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[3] *https://www.nature.org/content/dam/tnc/nature/en/documents/accelerating-large-scale-wind-and-solar-energy-in-new-york.pdf.*

Farms and agricultural lands are just as fragile as our environmental resources. The key is to use sensible planning to ensure, that in meeting the challenges of one environmental problem, we don't create new problems and other adverse environmental impacts. Local agriculture and agricultural resources need to be accorded more value in siting decisions, to protect productive agricultural lands and forestlands for our future. The [COVID] pandemic and its exposure of a broken food system is a sharp demonstration of the community need for a robust supply of local farm products.

There are many but yet mostly untapped opportunities to promote dual use of farms where agricultural activities can take place simultaneously with energy generation. Dual use (often referred to as 'agrivoltaics') can promote use of native grasses and pollinator-friendly plants to provide habitats for butterflies and support bees that farmers rely on. Sheep grazing on solar farms is an excellent opportunity that meshes agricultural opportunities and entrepreneurship with renewables, but is neither required, nor easily accepted by the solar developers (See *Solar and Multiuse Farming,* attached). There is a great need for information, incentives and in some cases requirements, to promote these opportunities for agrivoltaic uses. Should that take place, we must also address lack of markets and processing for sheep and their products. This is an example of ways solar development can provide multiple benefits and provide a way to help farmers use solar as a steady revenue stream.

In light of these challenges, I urge Congress to consider establishing programs and policies that address these problems. These include:

1. Promote local planning that assists local communities in assessing renewable energy capacity in a way that involves local residents in a meaningful way. This includes supporting local planning efforts such as comprehensive planning, natural resource inventories, and open space planning. These plans need to establish methods that allow for renewable energy projects in appropriate areas supported by the community. Financial resources are needed for conducting these basic community planning efforts. These are grassroots efforts that help engage people and promote communication. This will ultimately empower local communities to accept renewables into their economy.
2. Provide assistance in the form of technology and staff to help these communities navigate myriad sources of information. Fund agencies such as Cooperative Extension or others to serve as information clearinghouses to aid rural communities.
3. Promote application by solar developers of best management practices that preserve environmental and especially, scenic resources. These are major barriers and must be addressed.
4. Establish policies that incentivize use of disturbed sites first, as well as rooftop, parking lot, and building-integrated solar facilities in all locations—rural and urban—first instead of green locations. Do not put rural areas in the position of having to supply all renewable energy to urban and suburban areas.
5. Collate existing models developed across the States to identify farmland criteria to steer renewable energy facilities to locations that preserve valuable farmland needed for food production, and require or incentivize application of these criteria.

7.* Require or incentivize use of agrivoltaic's in renewable energy siting and involve the farm community early in siting so that the farm community can benefit from renewable facilities.

8. Promote smaller-scaled facilities that are truly 'community facilities' so that renewable energy production has greater benefits locally.
9. Promote use of host community agreements so that affected communities see benefits.
10. Further, address tax issues and support training for those involved in taxation of renewable facilities to enhance effectiveness and fairness of PILOT agreements that are negotiated—again to offer local benefits.

Conclusion

I urge Congress to establish national policies related to siting of renewable energy facilities and to enhance planning tools and principals when thinking about ways to expand the renewable economy. In so doing, consider the complex and multi-fac-

*__Editor's note:__ there was no item number "6." in the submitted statement. It has been reproduced herein as submitted.

eted experiences, expectations, and values of rural residents, find ways to promote renewables in a way that recognizes and balances the often-competing community goals and needs, and establish programs, requirements and incentives that positively involve rural communities and residents in the renewable economy rather than imposing it on them.

ATTACHMENT

Solar & Multiuse Farming

September 2019

www.seia.org *www.solargrazing.org*

Co-locating Utility-scale Solar with Livestock & Pollinators

Solar development and agricultural use can exist not only side-by-side, but increasingly are found together.

- A farmer can add solar to their property and get steady income from a land or rooftop array.
- Solar energy facilities can also collaborate with local farms and bee-keeping organizations to incorporate pollinator friendly plants and bee hives onto their sites.
- Responsible solar development could improve soil health, retain water, nurture native species, produce food, and provide even lower-cost energy to local communities.
- Sheep farmers have opportunities to contract for vegetation management of solar sites and thus increase farm viability.

Photo Credit: American Solar Grazing Association.

Benefits to Farmers

Farming is an extremely low-margin, competitive industry. If a farmer can add solar to their property and get steady income from a land or rooftop array, it can enable them to keep their farm.[1] Steady income from solar projects means that farmers are less vulnerable to fluctuations in market prices on their products. Especially for larger solar projects, local government and communities benefit from collected taxes and localized spending.

[1] *https://www.renewableenergyworld.com/articles/2016/04/solar-power-more-lucrative-than-crops-at-some-us-farms.html*.

"Solar grazing" is a method of vegetation control for solar sites that utilizes livestock, primarily sheep.[2] While solar grazing is currently in pilot phases on various sites, it is increasing in popularity. Solar companies can contract with local farmers, resulting in a relationship that is financially beneficial for both farmers and solar developers. Properly installed systems are benign to nearby animals.

According to a study conducted by Cornell University in 2018[3] and a study from the National Renewable Energy Laboratory in 2016,[4] co-location and solar grazing bring net positive benefits for farmers, in the form of hundreds of dollars per acre each year in additional income, and solar sites, through increased energy production and reduced maintenance expenses.

Solar energy facilities can also collaborate with local farms and bee-keeping organizations to incorporate pollinator friendly plants and bee hives onto their sites. There are many benefits to combining solar facilities with pollinator habitats:[5]

- Using one large solar field or perimeter screening area is akin to planting thousands of backyard pollinator gardens, which ultimately increases the productivity of farmland for miles around the facility.
- Planting native pollinator habitats reduces waste water runoff, and pollinator-friendly vegetation management practices, including minimal use of pesticides, results in more stable bee populations, benefiting farmers in the surrounding area.

Photo Credit: Pine Gate Renewables, North Carolina.

Solar Projects Can Improve Biodiversity

Solar farms can support a greater diversity of plants as well as greater numbers of butterflies and bees, particularly under management which focuses on optimizing biodiversity when compared to equivalent agricultural land. This increase in plant and invertebrate availability may lead to more opportunities for foraging birds in terms of invertebrate prey and seed availability.[6] When joint solar and vegetation designs are developed together, the benefits achieved can be maximized.[7]

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[2] Various livestock, and sheep in particular, may be sensitive to the preexisting mineral contents of the soil, and proper soil testing should always be done prior to grazing.

[3] Kochendoerfer, N. Hain, L., Thonney, M.L. (2018) The Atkinson Center for a Sustainable Future at Cornell University *https://www.solargrazing.org*.

[4] *https://www.nrel.gov/news/features/2019/beneath-solar-panels-the-seeds-of-opportunity-sprout.html*.

[5] *https://www.greenbiz.com/article/solar-farms-could-make-fertile-habitats-bees-and-butterflies*.

[6] Montag, H., Parker, G., Clarkson, T. (April 2016). *The Effects of Solar Farms on Local Biodiversity: A Comparative Study.*

[7] Macknick, J., NREL (June 2016) *Overview of opportunities for co-location of agriculture and solar PV*.

Photo: SouthHill Community Energy.

Solar Installations Could Be Win-Win-Win for Food, Water, and Renewable Energy

Responsible solar development could improve soil health, retain water, nurture native species, produce food, and provide even lower-cost energy to local communities. The Department of Energy's (DOE) Innovative Site Preparation and Impact Reductions on the Environment (InSPIRE) project brings together researchers from DOE's National Renewable Energy Laboratory (NREL), Argonne National Laboratory, universities, local governments, environmental and clean energy groups, and industry partners to better understand how to maximize local benefits.[8]

At several InSPIRE sites, local beekeepers and university and national laboratory researchers are tracking their bees' visits to the pollinator-friendly vegetation under the solar panels. The goal is to determine how vegetation at solar sites can benefit insect populations and to understand the extent to which pollinator-friendly solar installations can boost crop yields at surrounding farms.

The CHAIRMAN. Thank you.

Next, we have Mr. Aberle. Please begin when you are ready.

STATEMENT OF RANDY ABERLE, EXECUTIVE VICE PRESIDENT OF AGRIBUSINESS AND CAPITAL MARKETS, AGCOUNTRY FARM CREDIT SERVICES, FARGO, ND

Mr. ABERLE. Mr. Chairman [inaudible]. Excuse me. Should I start over?

VOICE. Yes.

Mr. ABERLE. Excuse me. I will start over.

Mr. Chairman, Ranking Member Fischbach, and other distinguished Members of this Subcommittee, thank you for calling this hearing today to discuss the renewable economy in rural America and allowing me to testify on behalf of AgCountry Farm Credit Services. My name is Randy Aberle. I am the Executive Vice Presi-

[8] *https://www.nrel.gov/news/features/2019/beneath-solar-panels-the-seeds-of-opportunity-sprout.html* and *https://openei.org/wiki/InSPIRE*.

dent, Agribusiness and Capital Markets at AgCountry Farm Credit Services based in Fargo, North Dakota.

AgCountry Farm Credit Services is a member of the Farm Credit System. We are a cooperative owned by our customers. We provide financing, crop insurance, and related services to more than 20,000 farmers, ranchers, agribusinesses, and rural homeowners in western Minnesota, eastern North Dakota, and central Wisconsin. We currently provide over $8 billion in loans through our 37 branch locations, and have nearly 600 employees. AgCountry and our customer owners are deeply involved in the renewable economy in a variety of ways. Farmers, ranchers, and agribusinesses are some of the most creative and innovative people you will meet. AgCountry has been lending to the biofuels and alternative energy industries for over 2 decades. I have personally served as the lead lender in financing over 23 biofuel plants. Each of these plants are multi-million-dollar enterprises owned by farmers and rural entrepreneurs. We are financing projects that reduce carbon emissions at these plants, which meet the Low Carbon Fuel Standards of California. AgCountry is also financing investments to capture waste landfill gas to power biofuel plant operations. Similarly, dairy farmers are utilizing anaerobic digesters to capture methane from manure lagoons to produce renewable energy, electricity, and renewable natural gas.

Beyond providing loans, we have shown support through sponsorships and regenerative agricultural research to improve the carbon footprint of agricultural production. AgCountry is currently in a public-private partnership with commodity and research groups, along with state funding, to finance crop research and a small-scale soybean crush facility in rural northwestern Minnesota. One goal of this project is to develop higher oilseed crops for use for feedstocks for renewable diesel and biodiesel production.

The renewable economy offers great opportunities for farmers, ranchers, and agribusinesses, and AgCountry is prepared to support our customers as they seek these opportunities. Financing biofuels and other innovative approaches for farmers and ranchers can be challenging. The size, technology, and maturity of the business all impact how lenders can best support the effort.

As lenders, we analyze different financial metrics when deciding on whether to finance a project. One of these metrics is recurring cash flows from operations. This measure helps determine if the project has the ability to repay the loan. Oftentimes, tax credits or incentives to invest in these types of projects are not enough to meet the required cash flow necessary to get these operations up and running to self-sufficiency. Financing start-up businesses can be particularly complex and challenging, especially when new technology is involved. A project champion or sponsor needs access to financial capital, which may come from a venture capital partner, where both the risk and reward expectations are very high. Technology, processes, and products must be able to be replicated for broad acceptance in the financial markets.

Congress could support new technology and start-ups by providing greater incentives, as well as more certain and predictable revenue streams for these capital investments to entrepreneurs or sponsors in order to cover start-up losses and loan repayment in

the early phases of a project. Additional public-private partnerships can work with adequate grants and investments that provide liquidity until sustainable cash flows can be generated.

From our own lending standpoint, we are doing everything that we can to make projects within the renewable economy work. AgCountry works with our customer borrowers to find reasonable solutions when plans do not materialize. As a farmer-owned cooperative, it is our mission to serve agriculture and rural America. These projects provide good paying jobs, new opportunities in our rural communities, and other potential revenue streams for farmers and entrepreneurs. Agriculture plays a vital role in environmental stewardship, and we believe farmers and ranchers are part of the solution to the climate challenges facing us today.

Thank you again for calling this hearing, and I would be pleased to respond to your questions.

[The prepared statement of Mr. Aberle follows:]

PREPARED STATEMENT OF RANDY ABERLE, EXECUTIVE VICE PRESIDENT OF AGRIBUSINESS AND CAPITAL MARKETS, AGCOUNTRY FARM CREDIT SERVICES, FARGO, ND

Mr. Chairman, Ranking Member Fischbach, and other distinguished Members of the Subcommittee, thank you for calling this hearing today to discuss the renewable economy in rural communities and for allowing me to testify on behalf of AgCountry Farm Credit. My name is Randy Aberle, and I am Executive Vice President of Agribusiness and Capital Markets for AgCountry Farm Credit Services, based in Fargo, North Dakota.

AgCountry Farm Credit Services is a financial cooperative providing financing, crop insurance and related services to more than 20,000 farmers, ranchers, agribusinesses, and rural homeowners in eastern North Dakota, western Minnesota, and central Wisconsin. We provide more than $8 billion in loans through our 37 locations throughout our territory and have nearly 600 employees.

We are a member-owned, locally-governed cooperative and a proud member of the Farm Credit System. Along with 70 other Farm Credit institutions, AgCountry shares a critical mission to support rural communities and agriculture with reliable, consistent credit and financial services, today and tomorrow.

Farm Credit is a nationwide network of borrower-owned lending institutions that share a critical mission assigned to them by Congress a century ago. These independent institutions include four wholesale banks and **67** retail lending associations, all of which are cooperatively owned by their customers: farmers, ranchers, cooperatives, agribusinesses, rural utilities and others in rural America.

Our mission is to ensure that rural communities and agriculture have a reliable, consistent source of financing irrespective of cycles in the economy or vagaries of the financial markets. Hundreds of thousands of farmers, agribusinesses and renewable energy producers around the country developed business plans this year knowing that Farm Credit has the financial strength to finance that plan and the strong desire and ability to help them succeed.

Farm Credit's unique cooperative structure means that the customer-owners who sit on our boards of directors are living, working, and raising their families in rural communities. They are deeply invested in the success of those communities and are interested in finding more ways for Farm Credit to contribute to that success.

Farm Credit is committed to supporting a diverse agricultural and rural economy, which certainly includes the renewable energy sector. Our customers span a wide range of climate smart and renewable energy operations including renewable fuel producers, farm operations with methane digesters selling energy back to the grid, biomass projects, and operations which have incorporated wind and solar energy production.

AgCountry and our customer-owners are deeply involved in the renewable economy in a variety of ways. Farmers, ranchers, and agribusinesses are some of the most creative and entrepreneurial people you will meet.

AgCountry has been lending to the biofuels and alternative energy industries for over 2 decades. I have personally served as the lead lender on 23 biofuel plants. Each of these plants are multi-million-dollar enterprises owned by farmers and rural entrepreneurs. We are financing projects that reduce carbon emissions at

these renewable energy plants, which meet the Low Carbon Fuel Standards of California. AgCountry also is financing investments to capture waste landfill gas to power biofuel plant operations.

Beyond providing loans, we have shown support through sponsorships in regenerative agricultural research to improve the carbon footprint of agriculture production. AgCountry is currently in a public-private partnership with commodity and research groups along with state funding to finance crop research and a small-scale soybean crush facility in rural northwestern Minnesota. One goal of this project is to develop higher oilseed crops for use as biofuel feedstock for renewable diesel and biodiesel production.

The renewable economy offers great opportunities for farmers, ranchers, and agribusinesses and AgCountry is prepared to support our customers as they seek opportunities.

Financing biofuels and other innovative approaches in the renewable economy can be challenging. The size, technology, and maturity of the business all impact on how lenders can best support the effort. [Profitability] in the sector can also vary greatly. For example, according to Iowa State University research, the average daily operating margin for U.S. fuel ethanol plants ranged from about 5¢ per gallon in June to over 40¢ per gallon in September.

Based on AgCountry's past experience, some biofuel projects can cost anywhere between $30 to $100 million or more. Multiple lenders, investors, and others often are required and AgCountry partners closely with other Farm Credit lenders, commercial banks, and equity investors to provide the total financing package necessary while spreading the financial risk among many institutions.

As lenders, we analyze different financial metrics when deciding on whether to fund a project. One of these metrics is recurring cash flows from operations. This measurement helps determine if a project has the ability to repay the loan. Oftentimes, the tax credits or incentives to invest in these types of projects are not enough to meet the required cash flow necessary to get these operations up and running to a level of self-sufficiency.

Financing start-up businesses can be particularly complex and challenging, especially when new technology is involved. A project champion or sponsor needs access to financial capital, which may come from a venture capital partner where both the risk and reward expectations are high. Technology, processes, and products must be able to be replicated for broad acceptance in the financial markets.

Congress could support new technology innovation and start-ups by providing incentives for capital investments to entrepreneurs or sponsors in order to cover start-up losses and loan repayment in the early phase of a project. Additional public-private partnerships can work with adequate grants and investments that provide liquidity until sustainable cash flows can be generated.

From our own lending standpoint, we are doing everything that we can to make projects within the renewable economy work. AgCountry is a patient lender that works with our customer-borrowers to find reasonable solutions when plans do not materialize. As a farmer-owned cooperative, it is our mission to serve agriculture and rural America. These projects provide good paying jobs, new opportunities to our rural communities, and another potential revenue stream for farmers and entrepreneurs.

Farm Credit is proud to serve as the financial partner to many of the nation's rural electric cooperatives and other rural power providers, many of which are making forward looking investments in renewable sources of energy. Farm Credit is working with rural communities and entrepreneurs across the nation to find additional opportunities to support the renewable energy industry.

As the Federal Government continues to find ways to grow this part of the agricultural economy, we firmly believe policies rooted in voluntary, science-, and incentive-based principles will spur growth in the agriculture industry and will ensure Farm Credit is able to best serve its current and future customers. We would also emphasize that government programs need to be transparent and income streams from them need to be predictable and certain, so lenders can include them in calculations to support loan making.

Thank you again for calling this important hearing. I would be pleased to respond to your questions.

The CHAIRMAN. Thank you, sir.

At this time, Members will be recognized for questions in order of seniority, alternating between Majority and Minority Members. You will be recognized for 5 minutes each in order to allow us to get to as many questions as possible. Please keep your microphones

muted until you are recognized in order to minimize background noise.

I recognize myself for 5 minutes.

I want to direct my questions to Ms. Stolzenburg. You spoke about rural communities lacking the resources to proactively identify locations with the right conditions for renewable energy facilities, which I think is a very important point to focus on. I introduced the Rebuild Rural America Act (H.R. 2361) with my colleagues, Reps. Bustos, Craig, and Spanberger, to provide consistent, flexible use funding to rural communities for locally tailored needs. This type of funding could be used, I believe, for planning for renewable energy multi-use solar development and more. I do agree it is critical that Congress provide resources to empower rural communities for projects that meet their needs.

In your testimony, you talked about the critical need for good planning, and you highlighted that there are models that exist for this effort. Could you elaborate a bit more on those models, and then as a follow-up, I would be interested to know how we could better promote, from your vantage point, those models.

Ms. STOLZENBURG. Sure, thank you.

So, the models really are based on use of tried and true comprehensive planning methods, which are grassroots programs that involve the community in understanding and identifying their values and—but the technology part of it is usually a geographic information system where we use mapped information to look at all of the resources in a community, from slope to wetlands and streams to prime agricultural soil, and using that technology, you can very easily identify and then apply criteria that, say, a solar facility might need to identify potential locations that address community identified features, as well as the facility identified features. And then through the comprehensive planning process, work with the community to identify locations that, again, meet that variety of local needs.

So, I think that it is both a planning model and the GIS-based model.

The CHAIRMAN. Thank you, and in terms of our ability at the Federal level to promote and/or provide resources and funding for these types of efforts, are you aware of any current Federal programs that have been utilized or can be utilized for these sorts of efforts?

Ms. STOLZENBURG. Not that I am aware of at the very local level. It is a huge need. Communities want to do planning and there are very few resources to help them gain the skills or the staff or the ability to get them done. So, I am not aware of a program at the national level that can help do that.

The CHAIRMAN. And separate and apart from potential funding sources, are there any other ways in which the Federal Government can support new renewable projects and new market opportunities for farmers?

Ms. STOLZENBURG. Well, as I mentioned, I think the agrivoltaics is a great example of something that can mesh renewable energy and opportunities for new types of agriculture. In my experiences, they have been resisted by the solar developers, at least around here, but there are lots of opportunities to mesh that, and that

would grow community acceptance if it was contributing to the local food systems.

The CHAIRMAN. All right. Thank you very much. I yield back.

Next, we are going to go to, I believe, Mrs. Fischbach, Ranking Member Fischbach.

Mrs. FISCHBACH. Thank you, Mr. Chairman, and I appreciate all of the testimony. I have taken a lot of notes, so I appreciate the opportunity.

Mr. Aberle, in your testimony you mentioned a project that you have been working on in northwestern Minnesota. I think I might know the project you are talking about. It is in my district. Could you talk a little bit further about the project and how does this project, and by extension AgCountry and the other sponsors, impact the renewable economy as well as the surrounding area economy?

Mr. ABERLE. Well, thank you, Congresswoman Fischbach. I would be happy to respond to that.

This project in northwest Minnesota gives the local region an opportunity to add value-added agriculture through continued research to develop the additional soy bioproducts that our representative from the Missouri Soybean testified to. As they develop more and many uses of the soybean, it is able to generate more revenue in local communities, providing jobs and more revenue sources for the area producers.

Specific to that region, there is a need to produce higher protein and higher oil soybeans for the markets for both the food-based product and for feedstocks for biofuel and renewable diesel. And so, this was an opportunity for our cooperative lending structure to utilize our core values and be responsible to each other and our cooperative, caring for ag and rural America, and play our role as a lender for this project through a collaboration with commodity research groups and commodity groups, along with state funding to get a project up and running, to continue this required research to get the commercial scale production on new products.

Mrs. FISCHBACH. Well, thank you very much, and I do know that that is quite a collaborative project. There are a lot of folks who came together, including AgCountry, to move that project along. So, I appreciate your involvement in that project, I only have about 3 minutes left.

Ms. Skor, in your written testimony, you listed data on state level economic impacts of the biofuel industry, and Minnesota was near the top. The lion's share of that impact comes from my district.

I am interested in your mention of the uncertainty as a result of the lack of year-round E15, and delayed RVOs from the EPA. Can you speak to the effects that that uncertainty would have on future development and investment in the industry?

Ms. SKOR. Certainly, Congresswoman. Thank you for the question.

As you well know, in the height of the pandemic, half of our industry was offline because of the drop in fuel demand. We are still getting our footing back as an industry. What we need is market stability and certainty, and strong signals. The Renewable Fuel Standard, as passed and intended by Congress, forces more blend-

ing of renewable biofuel into our fuel supply every year. We need those requirements to be set and upheld by EPA. Consumers should have year-round access to a low-cost, low-carbon fuel, E15, year-round. When we have year-round access to E15, when we have a Renewable Fuel Standard upheld as Congress intended, that is how we start to unleash the power of biofuels. That is how we become, yet again, a thriving economy that can, in turn, make the capital investments required for continued de-carbonization of our fuel and our ability to diversify the markets that we can play in, and including potentially sustainable aviation fuel.

Mrs. FISCHBACH. Thank you very much.

Mr. Aberle, can you speak to the effect that this uncertainty has from the financing perspective of it?

Mr. ABERLE. Yes, whenever there is a certain uncertainty and unpredictability to the cash flows of these companies, is always a concern for lenders for us to provide the stability of credit facilities to these ongoing businesses. And when those cash flows are then disrupted through policies and other uncontrollables, these companies have to react and sometimes, as was the case during the pandemic when they lost a lot of market share and they had to shut down production, it did disrupt the jobs and the business, and it made bankers more cautious about lending into this space in the future.

Mrs. FISCHBACH. Thank you very much, and I will yield back my 20 seconds, Mr. Chairman. Thank you.

The CHAIRMAN. Thank you.

Mrs. FISCHBACH. And thank you both for your answers.

The CHAIRMAN. Thank you.

I now recognize Representative Axne for 5 minutes.

Mrs. AXNE. Thank you, Chairman Delgado, and as we work on solutions to address the climate crisis, it is absolutely imperative that we utilize the tools that we have in rural America, and we take full advantage of the opportunities there to not just support our climate, but of course, our farmers. So, thank you for holding this hearing today.

And then, of course, one of our best solutions we have is the use of biofuels in our transportation sector. Biofuels, of course, support good paying jobs in our rural communities. It is a robust market for our farmers, and of course, addresses climate issues that we are facing.

So, I am thrilled to see that in the Build Back Better Act (H.R. 5376), my amendment, the one that provides for $1 billion towards the expansion of infrastructure for biofuels across this country, will help not just Iowans, but Americans.

So, Ms. Skor, my question first is to you, and thank you so much for being here and lending your expertise to the Committee.

As Congress debates the Build Back Better Act this week, what kind of benefits can we expect from the billion-dollar investment in biofuels infrastructure within the bill itself?

Ms. SKOR. Congresswoman, thank you so much for all of your work to make sure that that infrastructure funding is included in the Build Back Better Act. As you well know, this would be the largest investment in higher blend infrastructure we have seen to date. It really would unleash the power of biofuels. It gives us the

ability to work with our retail partners to accelerate the market inclusion of E15, which is a lower cost, lower carbon, higher value fuel choice for consumers. So, this is an unprecedented, wonderful opportunity for biofuels. It is great for American drivers, and it is certainly great for the rural economy.

Mrs. AXNE. Thank you for that, and I am looking forward to the Build Back Better Act getting put into law, and I sure hope that all my colleagues who are here today vote for it, because it is $1 billion in biofuels that we are talking about directly here.

Of course, another top priority for me is making sure that we get E15 year-round. We just talked about that a little bit, and as you know, earlier this year, a court case struck down the EPA's authority that had allowed year-round E15. I am very thankful for my colleague, Angie Craig, and her legislation to fix this issue to make clear that the EPA has the authority. That is legislation that I helped introduce.

And once again, we talked a little bit about uncertainty earlier in the previous question, Ms. Skor, but if we don't address this issue of EPA year-round and pass our legislation to allow year-round E15, how is that going to impact sales and the market opportunities for farmers?

Ms. SKOR. Well, I appreciate the question, and again, thank you for your support for year-round E15.

We agree this is a misguided court decision, and unfortunately, next summer—E15 is sold across 30 states. 85 percent of those retail locations will not be able to offer, for 3½ months next year, their consumers a lower cost, higher value fuel. E15 averages about 5¢ to 10¢ per gallon less than standard 87 fuel. It is a higher octane. It is cleaner burning. It is better for the pocketbook. So, this is something that we have to rectify. We appreciate your support, absolutely. We cannot realize the full potential of low-carbon renewable fuels without year-round access to E15.

Mrs. AXNE. Well, thank you, and those are some sobering numbers that we all need to be keeping in mind here.

I am also absolutely concerned that reduction of these E15 goals would impact our climate goals, they run in tandem. Earlier this year, a Harvard study concluded that corn ethanol reduces greenhouse gas emissions by nearly 50 percent compared to gasoline, all while being produced, of course, by our great farmers and communities across this country who support those economies.

So, my last question to you, Ms. Skor, is as we look for ways to de-carbonize, how can we utilize biofuels both domestically and internationally to take full advantage of carbon benefits?

Ms. SKOR. There are so many ways that we can better utilize biofuels, and as you said, we cut carbon emissions in half relative to gasoline today, and with technologies that are available today, we can become as an industry net-zero in terms of our carbon emissions.

We need strong policy signals to show that there is a marketplace and a growth opportunity. We need a strong Renewable Fuel Standard that blends 15 billion gallons of biofuel, of corn ethanol, every year into our fuel supply. We need year-round access to E15. We need infrastructure investments in terms of to allow for higher blends to be sold in 50 states across the nation. And importantly,

as the discussion in our carbon-focused world continues, we need to make sure that the carbon modeling and the measuring stick is fair, it reflects up-to-date science, and it accurately accounts for all of the innovation taking place at the plants and on the farms.

Mrs. AXNE. Well, you summed it up so well. We have 8 seconds left here, but thank you so much.

I want to continue to work with all of my colleagues here as we advance biofuels across the country to help our farmers and address climate change. I appreciate it.

The CHAIRMAN. I now recognize Rep. Thompson for 5 minutes.

I now recognize Mr. Scott.

Mr. AUSTIN SCOTT of Georgia. Thank you, Chairman Delgado, and I am going to focus my questions for Mr. Pratt, because his testimony highlights one of my primary concerns as we work to find the balance here on the economy, the environment, and especially rural Georgia.

Your testimony highlights the majority of the land area ideal for solar energy facilities in Georgia, my home state, is rooted in rural agriculture and that some communities have been challenged to find a balance between the competing interests of solar land use and traditional farming. And, I include forestry in that definition of *farming*. I am sure you are familiar with the project in south Houston County where approximately 800 acres of forestland was clear cut that provided a tremendous amount of wildlife habitat, that is no longer there.

My concern is that if we take the most fertile soil out there and whether it be forestland or whether it be farmland, and we convert that into solar fields, what the net impact of using that more fertile land is for solar fields *versus* less fertile land?

And so, can you speak a little more about the balance and the need to find less fertile land instead of more fertile land to put the solar fields on?

Mr. PRATT. Yes, sir. Thank you, Representative Scott. I think that is an excellent question, and I appreciate your service to Georgians.

I would say that there is—when you look at energy in general that we use, there is no free lunch. There are always tradeoffs in producing energy and environmental impacts, and that doesn't—solar is included in that, as you point out, the clear cutting of trees. The fact is, we cannot generate solar energy with shade. You have to have clear location to the sun.

I will say that we work hard to mitigate those efforts, in Georgia at least, through one of the other testimonies that said—and that is through agrivoltaics. And that really is bringing farm and biomimicry back to the land that occurred there before, and that is through—we have thousands and thousands of sheep on our farms, solar farms, going forward in the future. That is not the same as forestland, but it is a crop and it is a financial benefit for agriculture, and we hope to find those right balances and work really hard to do so.

Mr. AUSTIN SCOTT of Georgia. Okay. You touched on some of the supply chain disruptions. That is obviously another issue that I remain extremely concerned about, and I think that everybody on the Committee, regardless of party, is concerned about.

From the production of the solar energy and the other things that you are directly involved in, can you speak to the biggest issues for this subject about your primary concerns with regard to supply chains and what you are seeing right now with regard to the construction and development of solar panels, solar fields, and the other areas you are working in?

Mr. PRATT. Yes, sir. Those are extremely challenging areas for solar and other aspects of the utility business across the country. For solar specifically, most of the solar panels—the components are produced outside of the United States, and much of that is in China and some of the regulations and the supply chain issues associated with that country are creating bottlenecks to receive the materials that we need to propagate more solar in the United States.

But it goes beyond that. It is transwire. It is substations. It is equipment that is fundamental not only to solar, but to the rest of the electrical infrastructure as well. Bucket trucks, 3 years to receive a bucket truck [inaudible]. So, all those things are very important.

Mr. AUSTIN SCOTT of Georgia. Okay. My time has almost expired, but I appreciate you, Mr. Pratt. It does bother me to see so much wildlife habitat destroyed in the name of, if you will, the environment, and I do think that we need—if we are talking about environmental policy, we need to be looking at it from a whole, not from a piecemeal standpoint. And so, when you tear down all that forestland, you have water, you have wildlife habitat, you have a lot of area issues that that forestland is very, very good for. And when you get rid of it to replace it with solar panels, I think we would be better served if we were focusing on less fertile soils in areas that we put those fields.

So, thank you for your time.

The CHAIRMAN. I now recognize Representative Rush for 5 minutes.

Mr. RUSH. I want to thank you, Mr. Chairman. I was delighted, Mr. Chairman, that not one but two of our witnesses today are from cooperatives. I believe that co-ops are critical to putting resources directly into the hands of [inaudible] population and that a firm belief must further confirm your testimony today.

While cooperatives are empowering, they are unfortunately underutilized. To that end, Mr. Pratt and Mr. Aberle, how do we encourage the use of cooperatives, and specifically given the sharp decline in the number of African American farmers, how do we do so in areas with large minority populations? And further, have you given, both of you, any thought to how we may marry a cooperative-type approach to both rural and urban ag?

Mr. PRATT. Representative, this is Jeff Pratt. I will make a couple comments, and then pass it on to Mr. Aberle.

First, thank you for your question. Much of rural Georgia is impoverished and challenged, and much of the investment we are putting into those local communities provides very important tax revenue for those local governments. So, we are very glad to make that happen.

I will say that as far as marrying the urban and suburban and rural areas, much of the energy that is produced in those rural

areas from these solar facilities, in my example, is actually transmitted cost effectively to the more urban areas where there are also African American communities that benefit from that as well.

When you think of cooperatives in general, I would say that cooperatives are engaged in those local communities. They are owned and governed by the citizens that are in those communities, so land use and diversity are very important, and we take great pride to make sure those work.

Thank you, sir.

Mr. RUSH. Thank you.

Mr. Aberle, do you have any comments?

Mr. ABERLE. I would just add a few comments from our perspective.

One of our core values at our cooperative is that we advocate for our customers. And so, if there is a need out there in these rural communities, being able to serve agriculture and rural America is one of our core values and our mission out here, and we are very purposeful about that. So, if there is a need from a group of producers or farmers that have a common vision, we do try to care for ag and rural America, and try to advocate for them to meet their business goals.

And so, as a lender, we can only play a certain role, but as these groups get together and have a common vision, we certainly try to provide a pathway for them to meet their objectives and to serve that community.

Mr. RUSH. Thank you.

Mr. Chairman, with that, I yield back the balance of my time.

The CHAIRMAN. Thank you, Representative Rush.

I now recognize Representative LaMalfa for 5 minutes.

Mr. LAMALFA. Thank you, Mr. Chairman. I would like to direct this towards Mr. Pratt with the issue with generating electricity via renewables.

So, I come from northern California where we have burned millions of acres of forests over the last few years, and so, we have this material out there that already exists. We don't have to grow it. It grows on its own pretty much, especially when you look at 4 decades or so of nonmanagement of Federal lands, forestlands. We have approximately 170 million dead trees that aren't—you don't count in the burned trees in the state due to drought and insect infestation, and overcrowding of the forestlands.

So, what I am getting at is we have a lot of material out there that needs to find a home, a much better home than burning it via accidental forest fires, or even slash burning when it does get around to getting managed. So, what I am speaking of is having this material moved to a good end-use, such as generating electricity in a biomass plant. I wish we had much more of that in California. I wish we had a friendlier attitude towards it.

Mr. Pratt, what is your experience with the southern states also have vast forested areas and much crop that is taken off of them, and much that is converted into chip product of the waste material. We are not talking saw logs. We want to cut saw logs, too, because we need lumber. We need paper products as a byproduct. But we have a lot of material that isn't good for anything else other than either letting it burn in a forest fire or doing controlled burns,

which is only a little better, in some cases than as far as the smoke and CO_2 output and such. Please talk to us about the ability to convert more of this material into biomass and produce electricity, and have that be a green energy source.

Mr. PRATT. Thank you very much, Representative for that comment—or that question. That is a very good one, especially for Georgia, which has one of the largest harvestable timber crops in the country.

We do have a waste wood facility that burns waste wood, and much as you said, insect problems or the waste slash that results from forestry, and we burn at that facility in a boiler that creates renewable energy. There have been some questions about how green that method is. I would say that we believe it is quite renewable, and the reason is that when this forest product, as you mention, waste and slash lays in the forest, it decomposes and creates methane. Methane is 20 to 50 times more harmful to the environment than carbon dioxide. So, when we gather that waste and burn it in a way that creates energy and usable energy, we are also reducing methane to carbon dioxide, which is 20 times better, and gaining some electricity from that that will offset the petroleum-based generation as well.

So, I think it is a very helpful project, and something we ought to fully consider.

Mr. LAMALFA. You make a great point on that. A rotting forest is creating—or any rotting organic material is creating methane, whereas you can control that situation when you are burning in a controlled high heat situation with very, very low output. So, it ought to be looked at as a very green way of making electricity, because the other ways also have their costs of environmental purpose as well, when you are talking solar panels requiring mining of rare earths and materials like that. Everything has a cost to it, and that is what isn't acknowledged around here in the argument in the way it is looked at environmentally. And so, when we have—in my home state and yours, it sounds like too, we have already so much material that needs to be moved out of there to have a sustainable healthy forest situation, one that is drought-proof, insect-proof, and we need to be doing this yesterday.

So, Mr. Pratt, how friendly is Georgia towards looking at this material as a good source of electricity, and that it is a green way of doing so?

Mr. PRATT. It is friendly towards that, Georgia is, but it is also challenged because it is not as cost effective as solar in this case. I agree with you that looking at the whole economic picture is very important——

Mr. LAMALFA. Let me jump in on that. Cost effectiveness is very important, because we spend billions putting fires out in the West. We spend a lot also on the alternatives as well for green power. They are not cheap. None of these sources are cheap, but we have a material that will provide jobs in our backyard for the loggers, for the truckers and taking that material that is now a waste product, that is now a methane-producing product, as you mentioned, and one that is harming our air quality, our water quality, when the ash and such washes into our system, in our streams and rivers and lakes in California.

So, when you add up the whole spectrum of environmental cost, you are looking at an issue that is very, very expensive *versus* the subsidies that it would require to take the material from long distance to a power plant somewhere. I think the offset of that to the Forest Service, towards all those other things when you put it all up, put it on a point scale system there, you get a big win out of this.

So, I appreciate the time, and I yield back, Mr. Chairman.

The CHAIRMAN. Thank you.

I now recognize Representative Bustos for 5 minutes.

Mrs. BUSTOS. Thank you, Mr. Chairman, and thanks for holding this hearing today, and also thanks to our Ranking Member.

I am so excited about the opportunities for rural America and the role that we are going to be able to play and are playing already in clean energy. I really appreciate our witnesses here today who are testifying before us about how are we going to be able to execute on this successfully.

Let me start with biofuels. Obviously, the issue of climate rescue is perhaps the most pressing task of our time. It is a challenge that will require us to use every tool at our disposal. One of those tools, I am very proud to say, is corn ethanol, and it is a fuel that we know can cut carbon emissions in half, in half, compared to traditional gasoline. And the Congressional district that I serve in central and western and northern Illinois, we have seven biofuel plants in and around this district. We grow a little bit more than 1½ million acres of corn every year. It is critical that we protect the jobs that this creates, the livelihoods in rural America, and that we put biofuels on a level playing field with the other renewable fuels.

And as we continue to talk about the climate and we forge ahead, we can continue talking about new and innovative technologies, like sustainable aviation fuel, and how that will be a strong—and really, the need for a strong and unified model across sectors and how we calculate carbon emissions.

Let me start with my question for Ms. Skor, in your testimony, you mentioned that the Department of Energy's GREET model—I think you all know that that stands for Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies. But that GREET model, how that is a leading-edge model for measuring the carbon intensities of different fuels.

Would you please expand on how a unified model like GREET would be beneficial to driving down carbon emissions in a meaningful way, and specifically when it comes to biofuels policy in the motor vehicle and aviation sectors?

Ms. SKOR. Absolutely. Making sure that a model used to account for our carbon intensity accurately reflects in real time the most up-to-date innovations is critically important.

As you stated, the Department of Energy and Argonne National Laboratory through their GREET model, that is really the gold standard in terms of carbon modeling right now. It is updated every year. It has the most robust set of agricultural inputs to truly account for all of the practices and innovations taking place. And so, we need to use that modeling, whether we are talking about the RFS, EPA hasn't updated its modeling in 10 years, and also very

importantly, on sustainable aviation fuel, we need accurate modeling to make sure that we are competitive in the marketplace and we are eligible to compete for these new markets like sustainable aviation fuel.

Right now in the proposed Build Back Better legislation, the legislation is putting U.S. tax incentives based on a UN modeling agency, a modeling that they haven't updated in 10 years, and it is woefully inadequate relative to GREET. So, we very much encourage and support the use of GREET as a gold standard for all decisions on our ability to compete in the marketplace and to be eligible. That is what we need to be able to be a thriving industry, and to further reduce the intensity of our fuel and broaden the amount of markets we are eligible to compete in.

Mrs. BUSTOS. All right. Thank you, Ms. Skor.

Let me use my remaining minute and 15 seconds to shift to the electricity sector, and how renewables can make an impact in rural America.

So, rural electric co-ops all around the Congressional district I serve, whether it is Joe Carroll Energy or Spoon River Co-op, serve tens of thousands of our community members with reliable and affordable power.

Mr. Pratt, the Build Back Better Act would allocate nearly $10 billion for rural electric co-ops to reduce fossil fuel-related debt and invest in clean sources of electricity. What would that mean for your cooperative and others like it across the country, and what technologies would that help unlock for your organization?

Mr. PRATT. So, it would help buy down debt and stranded costs that potentially could result from mandates and requirements that might be required. It would also help us invest in clean energy technology, and it would help us look at mitigating the unintended consequences from some of this, which is batteries and other investments that are required to bring more intermittent resources onto the grid.

Mrs. BUSTOS. All right. I am out of time, and with that, I will yield back. Thank you very much to both of those witnesses who answered my questions. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

I now recognize Representative Balderson for 5 minutes.

Mr. BALDERSON. Thank you, Mr. Chairman, and thank you for the folks that are here speaking today. I appreciate you taking questions.

My first question is for Mr. Wheeler. Mr. Wheeler, the United States currently produces just under 1 billion gallons of renewable diesel annually. The Energy Information Agency announced this past summer that domestic production of renewable diesel could reach 5 billion gallons annually by 2024. Currently, ⅓ of soybean oil production in the United States is used toward biofuels, roughly 8.8 billion pounds. If renewable diesel production estimates from the EIA hold true and we see production multiply five times within a few years, I would assume the demand for soy oil will increase in a similar fashion.

How is your industry preparing for this possible surge in demand? And my follow up to that would be do you think this de-

mand will have an adverse impact on other soybean oil applications?

Mr. WHEELER. Thank you, Congressman.

Well, definitely here in the Midwest, we continue to expand our crush capacity, not just in Missouri, but definitely in the states that surround us. We have several that are going into Iowa. We are looking at two here in Missouri, and then there are other states as well that are looking at it into the Southeast as well.

As far as when it comes to meeting the demand, as farmers, we continue to try to build this out, and protect our current infrastructure within the biodiesel industry. There is definitely going to be enough production as far as when it comes to soybean and the soybean oil, and we are here to stand and support it.

Mr. BALDERSON. Thank you very much.

My next question is for Ms. Skor, and I would like to shift gears to ethanol. As you know, the United States is the largest global producer of ethanol, producing 56 percent of the world's ethanol. In your testimony, you mentioned the future of domestic ethanol production, and how the international market will play an important role in that. Can you elaborate more on the importance of having a Chief Agricultural Negotiator who works on behalf of American agriculture producers and processors, and why this position is so important to ethanol producers?

Ms. SKOR. There is a growing demand for low-carbon renewable fuels, not just domestically but globally as well, and I appreciate the question.

Typically, we export about ten percent of our product. Right now, Canada is actually our largest trading partner for ethanol. So, it is incredibly important that we as an industry continue to be able to grow, to provide our product not only to domestic supply as we look toward higher blends nationwide, but also in other countries that are looking to build their rural economies, keep gas prices affordable, and make sure that they can achieve their climate goals. And again, the solution for all of that, cleaner air, more affordable fuel choices, and boosting rural economies is going to be greater use of ethanol.

Mr. BALDERSON. Thank you.

My next question is for Ms. Bowman. I thank you also for being here.

You mentioned in your testimony the NAICS code which was required for biobased products in the 2018 Farm Bill has yet to be promulgated. Do you know why this is?

Ms. BOWMAN. We have been working with the various stakeholders in the Administration who are working on this issue. It is extremely important for this to move forward. Biobased products manufacturing is really lumped into broader manufacturing, so you are not able to see trends. You are not able to see market growth, where investment is needed. So, we would really call on Congress to work with OMB, USDA, and Commerce to get the farm bill mandate moved forward.

Mr. BALDERSON. Okay, and is this an issue that the USDA can solve on its own?

Ms. BOWMAN. I believe not on its own. USDA needs to work with Commerce, OMB is also involved. They oversee the interagency

committee that considers all of the recommended changes to the NAICS code, so I think all of those agencies are critical to moving this forward.

Mr. BALDERSON. Okay, thank you very much.

Mr. Chairman, I yield back my remaining time. Thank you all.

The CHAIRMAN. Thank you, and I recognize Representative Craig for 5 minutes.

Ms. CRAIG. Thank you so much, Mr. Chairman, and thank you, Ranking Member Fischbach, my fellow Minnesotan, for focusing on energy in rural America. Thank you so much to our witnesses here this morning.

I want to focus my questions today on biofuels and the role that they can play in helping to build our rural communities and the pocketbooks of hardworking Americans. Right now when I am back in my district, I am hearing a lot about supply chain shortages and higher gas and energy prices, in addition to increases in the price of groceries and other goods. I am also hearing from farmers who are wondering about all of these rumors swirling about the RVOs and that the Administration is considering. They thought they could expect robust numbers, not more relief for refiners. And I am wondering the same thing myself, actually.

It is clear to me, especially after hearing the testimony from Ms. Skor and Mr. Wheeler, that we need to be investing more in the biofuels industry right now as we seek to address energy costs. Ethanol and biodiesel blends have traditionally saved money for consumers at the pump, as cheaper, cleaner burning fuel options, and they drive rural investment, which means more and better paying jobs in rural communities.

But biofuels are also subject to policy decisions, just like the other fuel sources that Americans rely on. So, I would like to focus on the policy decisions in front of us now. First, the Administration should immediately issue robust RVO numbers for 2022. This delay has gone on for far too long. Second, we should make E15 available year-round across the country. Ms. Skor, thank you for mentioning my bill in your opening remarks, the Year-Round Fuel Choice Act of 2021 (H.R. 4410), and this should be passed as soon as possible by this Congress. And I am glad you also mentioned the $1 billion in biofuels infrastructure, which I believe is so critical in the Build Back Better Act. Cindy Axne, my great colleague from Iowa, and I have been leading the fight to extend the biodiesel tax credit through 2026, and I think we have to move immediately.

Because with gas and energy costs rising, we would be fools not to address the roles that biofuels can play in reducing price pressures for Americans across the country.

With that in mind, I would like to turn to Ms. Skor for the first question.

In your written testimony, you included a chart that demonstrated clearly that RIN prices are not correlated with gas prices, which is an argument that we often hear from fossil fuel companies. With that in mind, can you speak to the role that biofuels play in placing downward pressure on gas prices and helping Americans save money on fuel and energy costs?

Ms. SKOR. Absolutely, Congresswoman, and you mentioned the two things that are going to help us reduce the price of fuel for con-

sumers, a strong Renewable Fuel Standard, and year-round sales of E15. The more biofuel we blend, the greater our ability to reduce gas prices. This year, according to the EIA, the retail price of gasoline in average has gone up by $1 per gallon. That is a hard hit for working Americans in all 50 states. So, with a strong Renewable Fuel Standard that encourages and really requires more blending of low-cost biofuels with year-round sales of E15, that is how we can really support drivers and make sure that we are managing fuel costs appropriately.

Ms. CRAIG. Let me just follow up your view moving forward with the regulatory certainty that would come from year-round sales of E15. How would the industry be ready and poised to provide renewable fuels across the country?

Ms. SKOR. We are absolutely ready and poised to do that now. In fact, we have had 3 summers of year-round E15. Consumers have already driven 25 billion miles on this fuel. It is a fantastic fuel. It is a great value for the consumers. We simply need to return back to the marketplace that we had for the past 3 years. We are absolutely ready and able, and retailers too are anxious to be able to offer this choice to their consumers.

Ms. CRAIG. Thank you so much for your perspective, Ms. Skor, and your comments really do help highlight the important role that biofuels play in today's renewable energy economy as we look to alternatives to traditional fossil fuels.

As you know, I am leading that Year-Round Fuel Choice Act to make sure that access to E15 for all the reasons that you talked about, to lower the cost at the pump, decrease the carbon intensity of our transportation sector, and support family farmers and the biofuels sector. I will continue to focus on the role that they play in the renewable economy of rural America.

Thank you so much, Mr. Chairman, and I yield back.

The CHAIRMAN. Thank you, and I recognize Representative Feenstra for 5 minutes.

Mr. FEENSTRA. Thank you, Chairman Delgado and Ranking Member Fischbach.

My district leads the nation in biofuel production, making it a pillar for Iowa's rural economy. According to the 2021 report from the Iowa Renewable Fuels Association, Iowa produced 3.7 billion gallons of ethanol and 351 million gallons of biodiesel in 2020 alone. Additionally, the industry supports over 40,000 jobs. Ensuring that our biofuel producers are prioritized through strong renewable volume obligations, RVOs, levels is not only critical for the industry but it is also my many constituents who engage with the economy built on its success.

Ms. Skor, how has a lack of the RVO announcement inhibited the biofuels industry?

Ms. SKOR. Thank you for the question, Congressman.

As I mentioned, we are still in the mode of recovering and getting back on the road to recovery from COVID, at a point when our fuel demand nationwide was cut in half. And so, we absolutely need some certainty and stability and clarity in terms of the marketplace opportunities. This is required not only for us to get fully back on our feet, but for then in turn for us to have the capital investment required to continue R&D so we can continue to de-car-

bonize our fuel and diversify the co-products that we are able to provide across America.

Mr. FEENSTRA. Ms. Skor, can you share your vision on how biofuel production and the use fits into the future clean energy format?

Ms. SKOR. We are already an active participant in our nation's climate strategy, I would say. The State of California with its Low Carbon Fuel Standard, biofuels account for 80 percent of the credits in California's Low Carbon Fuel Standard. So, we are a low-carbon renewable fuel plant-based homegrown here in the U.S. We have the ability to do so much more by use of higher blends nationwide to make sure that we have modeling that accurately reflects all of the innovations taking place on the farm and at the plant. So, we have the ability to make sure that the 270 million cars on the road today are using a low-carbon fuel, and with a strong industry, we can also do the R&D to expand into hard to electrify spaces like sustainable aviation fuel.

Mr. FEENSTRA. I am glad to hear that, Ms. Skor. Thank you for those comments. I believe exactly what you said, the future of biofuels and renewable energy is strong, and we are hearing today through these testimonies that this is the case. And as you noted, Biojet Fuel Research Act (H.R. 5620) that I am working on would create a working group to analyze the future of sustainable aviation fuel, very important.

I have another area. As the renewable economy grows, it is important that the Federal Government provide updated and accurate data on lifecycle emissions, such as through the GREET model.

Ms. Skor, are there any changes to the GREET model that we would benefit from or that the biofuels industry should know about?

Ms. SKOR. One of the wonderful things about the GREET model is that it is updated every year, and there is an incredibly robust data set, a lot of inputs going into the modeling specific to agricultural innovations. So, we would like to see that standard of carbon modeling used in every policy where we are talking about incentivizing low-carbon fuels and rewarding companies and private-sector for producing low-carbon fuels.

So, we absolutely support using that and applying that in really any context.

Mr. FEENSTRA. Yes, thank you. I fully agree with you.

Biofuels like ethanol are low-cost and low-carbon solutions, and they can be carbon negative in the next decade. I mean, I just looked at carbon sequestration that we are looking at in Iowa for biodiesel and ethanol plants. I mean, there are so many things that are happening right now.

An announcement for the strong RVO levels will encourage investment and innovation in this already proven industry that deserves and will create decreasing carbon today. I am very passionate about this.

Thank you everyone for your testimonies, and I look forward to working with everyone as we further go down this path. Thank you.

The CHAIRMAN. Thank you.

I now recognize Representative Plaskett for 5 minutes.

Ms. PLASKETT. Thank you, Mr. Chairman, and thank you to the witnesses who are here. This has been very enlightening, and thank you for your research and the work that you are doing in this area.

Mr. Wheeler, I wanted to ask you a question. Can you talk about what role an extension service can play in educating farmers on the benefits of bioeconomy?

Mr. WHEELER. Thank you, Congresswoman.

One of the most important things that an extension program can do is that very thing, is to educate. One of the main things that we are lacking throughout the United States for our land-grant institutions are resources. So, one of the main focuses that we focus on here in Missouri and the surrounding states specifically is on the research side, and making sure that we carry out that not only the land-grant institution mission and its vision, but also the mission and vision of its very farmer and its check-off. So, it is—I know it is very important to a lot of states. I know it is here in Missouri, and we continue to grow that effort and be laser-focused in that effort to bring in additional resources, but as well as find ways to reach those producers and our farmers.

Ms. PLASKETT. What difference do you think that reach could make on their businesses?

Mr. WHEELER. I believe—well specifically, it is getting the farmer to us. That is one of the very difficult things that we have, because as any farmer, they are very independent and they are all small businessmen and -women. So, there are a lot of folks that actually struggle with that, to be able to reach out. But the ultimate goal through the extension program on a county basis is getting that research and that information to those businessmen and -women so they can make more informed decisions to the very point that you are referring to.

Ms. PLASKETT. Thank you, and I know that the farmers in the Virgin Islands would appreciate that.

This is a question to any one of the witnesses. My district and other remote areas of the United States have developed energy plans to move forward further away from relying on petroleum for power and fuel. The non-contiguous areas of the country and other remote areas understand the burden of high energy costs. Being isolated, not having scale, not being able to connect to other areas. One proposal to address this in the Caribbean region is the Renewable Energy for Puerto Rico and the U.S. Virgin Islands Act, H.R. 2791, which would create a USDA grant program for investments in renewable energy, energy efficiency, energy storage, smart grids, and microgrid projects in territories of the United States.

Can any of the witnesses speak to the importance of developing and using renewable energy sources in small, rural, remote areas?

Ms. SKOR. I will go ahead and start, Congresswoman. Thank you for the question.

I think it is mission critical that all consumers have access to renewable energy sources, whether they are in an urban environment or a rural remote environment. On behalf of the ethanol industry, we are very proud that we are able to provide renewable fuel that is low-cost and affordable for all communities. That is one of the reasons that we want to see greater use of ethanol to extend our

fuel supply and make fuel supply more stable, and also more low-cost. So, I appreciate the question.

Mr. WHEELER. Congresswoman, Gary Wheeler.

I think one of the main things, it goes back to there are a lot of us that have referred to it as HBIIP, but it comes back to infrastructure and the resources that can be provided to those regions. Infrastructure throughout the entire United States, whether it is biodiesel or increase E15, it really boils down to resources being laser-focused and making sure that those dollars are being spent where they need to be spent.

Ms. PLASKETT. Thank you.

Mr. Aberle, did you have something you wanted to add?

Mr. ABERLE. The only thing I would add is that when you talk about investment and research to design and build out the successful technology platforms, whether they are microscale or large-scale projects, there has to be a path of proven technology before other stakeholders are willing to invest in that. And providing dollars for initial scale and demonstration scale projects is valuable in identifying that technology pathway to be replicated to larger stakeholders.

Ms. PLASKETT. Thank you, I appreciate that. And thank you for the time, Mr. Chairman. I yield back.

The CHAIRMAN. Thank you, and I recognize Representative Davis for 5 minutes.

Mr. DAVIS. I was actually—you were right on the edge of time. I mean, I was waiting for you to yield. I would have taken those last 2 seconds, Ms. Plaskett.

I do want to say thank you—unfortunately, I want to say thank you to Ranking Member Fischbach and fortunately to Chairman Delgado for having this hearing today to discuss important renewable energy production issues in rural America, and the work that our ag producers are already doing to reduce emissions.

This Administration, though, is headed down a dangerous path as it continues to pass up opportunities to uphold the Renewable Fuel Standard, and support America's ethanol and biodiesel producers. I have been proud to lead initiatives to strengthen and restore the integrity of the RFS, alongside my friends in my biofuels Democratic and Republican co-chairs. My colleagues on this Committee, Ranking Member Fischbach and Mr. Feenstra, have also been key in our efforts to hold this Administration accountable. In June, I sent a letter along with my Republican colleagues to President Biden regarding the rumors that the Administration was considering a nationwide waiver of the RFS to cut demand for more combined gallons than all those cut due to the small refinery exemptions issued by the prior Administration. And we encouraged the President to keep his 2020 promises to rural America and actually uphold the law.

Now, we continue to wait on the RVO and have yet to receive a response to our letter, which is actually concerning. I hope that this is not an indication of the Administration's unwillingness to stand with America's farmers. And further, in March I sent a letter with my Republican colleagues to the USDA encouraging the Department to quickly provide assistance using existing funds to biofuels producers for COVID-related market disruptions. Secretary

Vilsack responded to that letter in August, stating that an update to the Pandemic Assistance for Producers Program at the USDA would be provided by Labor Day. However, we are still waiting. Eleven months into this Administration and no biofuels producers have seen any relief.

Mr. Chairman, I request unanimous consent to insert into the record the three letters I referenced.

The CHAIRMAN. Without objection.

[The letters referred to are located on p. 95.]

Mr. DAVIS. Thank you.

Madam Ranking Member, do you object?

Mrs. FISCHBACH. Never.

Mr. DAVIS. Thank you.

First question. Ms. Skor, great to see you again. I want to know, has any prior Administration considered retroactively cutting the RVO in the way this Administration is rumored to be considering?

Ms. SKOR. Thank you, Congressman, and thank you for all your leadership as a Member of the House Biofuels Caucus.

No. The rumors that we have heard, that this EPA is looking to reopen the 2020 blending requirements for RVOs, that is unprecedented and we believe there is no legal authority for the agency to do that.

As you said, we need to get these renewable blending obligations out. They need to be at Congress's intent of 15 billion gallons of conventional blending. So, we are still waiting, too.

Mr. DAVIS. Mr. Wheeler, what do you think?

Mr. WHEELER. Congressman, it is unprecedented for sure, and just want to say I greatly appreciate all your leadership and your work down in Illinois, and it is good to see you as well.

Mr. DAVIS. Great to see you.

Ms. Skor, do you believe the biofuels industry is better or worse off under this Administration?

Ms. SKOR. Well, as we have said from the outset, the first real test of the Administration is commitment to follow through on many of Mr. Biden's comments stated on the campaign trail is with the Renewable Volume Obligations. We have yet to see those. We are anxiously awaiting. That is going to be really the first test to show that they are committed to low-carbon renewable fuels that can be used in our current auto fleet.

Mr. DAVIS. And this is our test right now, Ms. Skor, this is the test of the Administration. I mean, these are rumors but a lack of response to letters coming from Members of Congress, and a lack of response to questions coming from your industry, it only leads us to speculate, right?

Ms. SKOR. Speculation and uncertainty, and that is not what our marketplace needs right now. So, we are already well past our 2021 blending obligations. We have to get 2022 out so that we get back on track, which is something that the Administration had committed it would do at the outset, the beginning of the year.

Mr. DAVIS. They committed, they campaigned to be elected on keeping the promise to America's biofuel producers in upholding the RFS, and all we hear right now is silence. That, to me, sounds like an almost—and hopefully this hearing will help change that—but it sounds to me like it is almost a broken campaign promise.

And I will tell you, we here, we Republicans who have sent these letters, we will hold this Administration accountable.

So, what can this Administration and we in Congress, Ms. Skor, do right now to provide certainty to your industry?

Ms. SKOR. What we need is to get those renewable volume blending requirements out. They need to be at 15 billion gallons. We need to restore year-round sales of E15. So, we get back on track and we can use more biofuels. They are good for the rural economy. They are good for the American driver.

Mr. DAVIS. Thank you. I yield back my 2 seconds.

The CHAIRMAN. Thank you.

I recognize Representative Cammack for 5 minutes. Thank you.

Mrs. CAMMACK. Well, thank you, Mr. Chairman. Thank you, Ranking Member Fischbach, and to all our witnesses for being here today, as well as virtually.

It has been noted here several time already that our agricultural producers and businesses are some of the most entrepreneurial, forward-looking people out there today, and I think it is important to remember that this entrepreneurial innovative spirit, not government directives, is pushing American agricultural operations to make these new choices, like a dairy just outside my district that is making the choice to construct and operate a digester. Or as is the case with one operation within my district, leading the way in developing a biomass facility to energy with zero emissions that can produce electricity, heat, and high-quality biochar and diesel from wood waste. In a state like Florida, wood waste is plentiful, especially after a storm. Not only can this plant operate connected to the grid, but it can also operate as emergency support for critical infrastructure when other energy sources have been knocked offline. In a state like Florida, a plant like this one and others can provide a lifeline for critical infrastructure in the wake of a hurricane or other disaster.

As the Ranking Minority Member of Emergency Preparedness, Response, and Recovery Subcommittee of the Homeland Security Committee, this is an issue that is very close and near and dear to my heart. Great synergy here for what we are talking about.

This is a great example of private capital and innovation coming together in rural America to identify an opportunity that has the added effect of helping to protect our environment for generations to come. We need to find ways to encourage this private activity and innovation.

Now, I know that we have kind of circled around this and you have answered this a few different ways, but Mr. Aberle—and I hope I am saying that right—can you talk a little bit about the Federal policies and whether they help or hurt in the search for predictability in the marketplace as we are looking to finance these projects? And my follow up would be the uncertain nature of future cash flows needed to finance a project. I know you have talked a little bit about this and Ms. Plaskett hit on this as well, talking about proven technology and the pathway for stakeholders, oftentimes a pilot program. But just getting that off the ground, can you talk about some of the challenges within financing and what we might be able to do to clear the path?

Mr. ABERLE. Well, thank you for that question, Congresswoman.

We have been involved in this space for a long time, and I was fortunate to be involved in the build-out of the ethanol industry by financing Greenfield Construction and new plants. From that perspective, the Federal policies that are in place really do put a floor on the business plan to give the entrepreneurs courage to move forward, and it also gives the lenders more courage to share or partner with them on developing new technologies to develop that pathway. It may not be the optimization of that business plan, but it does provide a floor where they can address the capital needs and the liquidity that they are going to need for a successful project.

And so, by having Federal policies in place, it does give them kind of a rock to start their foundation on for a successful biofuel or renewable project.

Mrs. CAMMACK. Are there particular programs in which you have seen success, and how might we be able to expand on those to make them better, more efficient, hit our intended targets, *et cetera?*

Mr. ABERLE. Well, the RFS was one example of one great one, because there was a market out there that was already built that needed to be served. And so, they knew when they built the project that there was to be a place for that product to go and be developed into the market. And so, that was the stepping stone to build out all these ethanol plants across the country.

Mrs. CAMMACK. Thank you.

Mr. Pratt, you mentioned that intermittent energy production can be challenging to grid operations, so what kind of activities do you undertake and equipment do you install to compensate? Now, are these mitigation efforts complicated, expensive, or both, and can you provide examples of renewable energy sources of energy where they come without the problem of intermittency?

Mr. PRATT. Representative, thank you very much for your question.

So, yes, your second question first. Intermittent resources, renewable resources that are not intermittent would be biomass, waste biomass, as you mentioned. Digesters can be that as well. So, you make good examples with those. Solar energy is more intermittent, so is wind. We also have geothermal out West, and that can be more consistent.

So, what we are doing is looking at different technologies like batteries and grid enhancements and controls technology to help mitigate intermittency.

Mrs. CAMMACK. Excellent, thank you so much.

And with that, I yield back.

The CHAIRMAN. Thank you. I now recognize Representative Baird for 5 minutes. You might have to unmute.

Mr. BAIRD. Sorry about that. I thought I already had. Anyway, I really appreciate, Mr. Chairman and Ranking Member Fischbach for holding this hearing, and I really appreciate the witnesses being here and the technology that they bring and share with us.

My first question, then, goes to Mr. Pratt. I really enjoyed your testimony and hearing about your organization and how they work to bring technological enhancements to your members, and I feel that the nation's rural electric co-ops do have an important role to play in the renewable marketplace. And it is interesting to me how

you use the RUS program to help support your efforts for these facilities in Georgia's grid.

But anyway, I was reminded of the interest in my district and the state to leverage the generation potential of anaerobic methane digesters, so this potential to harness the co-product of one of our nation's animal protein industries is often stymied by the difficulty and cost of getting these kinds of operations connected to the grid.

So, Mr. Pratt, do you have any insight on how the livestock producers could be incentivized or we could be more supportive in helping them to connect the output of these digesters into the rural electric grid?

Mr. PRATT. Yes, sir, Representative Baird. I appreciate your question about digesters.

First, I think there is a lot of potential for digesters, and there are quite a few in the United States, but they aren't as inexpensive to produce energy from as solar energy today, so they have some headwinds for utilities in that respect. That does not mean they are not important. In the larger picture, I think they can be very helpful. There has been some difficulty in maintaining reliability of those facilities; however, I think the technology continues to change and there will be opportunities for both low interest loans from the USDA and RUS, as you mentioned. I think that making sure they have access to the similar tax credits that other forms of renewable energy could be helpful, and I think it could also be very beneficial to those agricultural and rural communities to dispose of waste in a very economical and helpful fashion, and produce some energy while we do that.

Mr. BAIRD. That is great. I think we have some food waste that we could probably incorporate into that same system, as well as the forestry industry and some of that. It would be a feedstock for these kinds of digesters, so I think that has potential and I really appreciate your comments.

Next, I want to go to Mr. Wheeler. You made reference to the PoreShield project that can be used to extend the longevity of our nation's bridges and concrete. That is sort of exciting to me, and you did that work in cooperation with the soybean farmers in Indiana, as well as Purdue University. So, I am just going to give you the opportunity to expand on that product and its use, and what spurred you to make that kind of discovery?

Mr. WHEELER. Sure. So, thank you, Congressman.

Well, it was actually developed in Indiana in partnership with their farmers and the check-off, and so, it is a perfect example of where the check-off can really partner on a public-private position and develop new products, biobased products.

We specifically use PoreShield here at Soy Innovation here in Jefferson City, Missouri, on a lot of our sidewalks, but we also participated in a pilot project with the Soy Transportation Coalition also provided through our check-off programing and our farmers, and we partnered with several different municipalities here in the State of Missouri and across the Midwest to showcase what PoreShield can actually do, and lengthen the life of not only concrete, but also asphalt. So, this is just one of many projects and ideas that have come to fruition over the past several years that

is produced from this little thing we call the soybean, which is magnificent.

So, thank you for your passion as well as our passion as well, and there will be many more products that will be coming out into the future. Thank you for the soybean farmer and our check-offs. So, thanks for the question.

Mr. BAIRD. Thank you very much, and it looks like I have about 10 seconds left, so I yield back my time.

But Ms. Skor, I was going to ask about the reduction in greenhouse gas emissions by 46 percent by using ethanol, but I am out of time, and so, I yield back.

[The information referred to is located on p. 98.]

The CHAIRMAN. Thank you.

Before we adjourn today, I want to invite Ranking Member Fischbach to share any closing comments you may have.

Mrs. FISCHBACH. Well, I just want to say thank you so much. I think it has been a very helpful conversation, and I think that we need to continue to make sure that we are recognizing and promoting the biofuels as something that is a part of our entire ag economy and part of that carbon emissions reductions, and so we need to continue the conversation, and I appreciate Congressman Davis talking a little bit about what is going on within the Administration.

Mr. DAVIS. What about science? Where are we at on it?

Mrs. FISCHBACH. But I will just say thank you so much for being here, and I appreciate the conversation and we will continue the conversation, and thank you, Mr. Chairman, for putting the Committee hearing together today.

The CHAIRMAN. Thank you, Ranking Member Fischbach.

As we bring this hearing to a close, I would want to again express my gratitude for the expertise provided today by our panel of witnesses, along with the work that you all do to keep our rural communities thriving.

I represent the eighth most rural Congressional district in the country, so to be able to facilitate a conversation like the one we have had today gives me hope that this Committee can continue to work for rural America and find commonsense solutions that improve the economic, social, and environmental well-being of our communities.

Under the Rules of the Committee, the record of today's hearing will remain open for 10 calendar days to receive additional material and supplementary written responses from the witnesses to any question posed by a Member.

This hearing of the Subcommittee on Commodity Exchanges, Energy, and Credit is adjourned.

[Whereupon, at 12:04 p.m., the Subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

SUBMITTED LETTERS BY HON. RODNEY DAVIS, A REPRESENTATIVE IN CONGRESS FROM ILLINOIS

LETTER 1

March 24, 2021

Hon. THOMAS "TOM" J. VILSACK,
Secretary,
U.S. Department of Agriculture,
Washington, D.C.

Dear Secretary Vilsack,

As you know, as part of the agricultural economy, the biofuels industry has been subject to immense financial distress due to the COVID–19 pandemic. Many of our local ethanol and biofuels plants continue to recover from dramatic demand loss in 2020. While demand for fuel has increased, past losses must be addressed.

Rural communities and agricultural economies where the biofuels industry plays a major role are still grappling with the economic impacts of COVID–19. To that end, we respectfully urge you to use remaining funds provided by the Coronavirus Aid, Relief, and Economic Stabilization (CARES) Act (P.L. 116–136) and the Consolidated Appropriations Act of 2021 (P.L. 116–260), to support our biofuels producers. These packages passed on an overwhelming bipartisan basis with the intent of providing broad assistance to producers, and biofuels should not be left out.

While the biofuels industry, along with our other impacted agricultural producers have waited for nearly 2 months for the Coronavirus Food Assistance Program (CFAP) to reopen, our local farmers continue to struggle. CFAP has played a critical role in keeping many of our local farming operations afloat prior to the Administration's freeze on the Program that started in January. Assistance must resume and action must be taken immediately to provide parity, and much-needed assistance to the biofuels industry.

We encourage you to expeditiously reopen the program and provide aid to our local biofuels producers and processors to sustain good-paying local jobs, and keep key markets open to our local farmers. It is critical that this Administration acknowledge Congressional intent and provide targeted relief to the biofuels industry as outlined in the bipartisan Consolidated Appropriations Act of 2021 (P.L. 116–260), and quickly send payments to our local producers.

We stand ready and look forward to working with you on solutions to bolster Rural America, and to ensure relief for the biofuels industry along with other sectors of the agricultural economy. Thank you for your consideration of this request.

Sincerely,

Hon. RODNEY DAVIS,
Member of Congress

Hon. ADRIAN SMITH,
Member of Congress

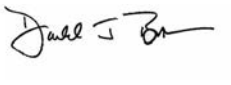
Hon. DUSTY JOHNSON,
Member of Congress

Hon. RANDY FEENSTRA,
Member of Congress

Hon. MICHELLE FISCHBACH,
Member of Congress

Hon. JIM HAGEDORN,
Member of Congress

Hon. DARIN LAHOOD,
Member of Congress



Hon. DON BACON,
Member of Congress

Hon. ANN WAGNER,
Member of Congress

Hon. TOM EMMER,
Member of Congress

Hon. BLAINE LUETKEMEYER,
Member of Congress

Hon. MIKE BOST,
Member of Congress

Hon. ASHLEY HINSON,
Member of Congress

Hon. MARIANNETTE MILLER-MEEKS,
Member of Congress

Hon. JAMES R. BAIRD,
Member of Congress

Hon. ADAM KINZINGER,
Member of Congress

LETTER 2

August 19, 2021

Hon. RODNEY DAVIS,
Member,
U.S. House of Representatives,
Washington, D.C.

Dear Congressman Davis:

Thank you for your letter of March 24, 2021, cosigned by your colleagues, to the U.S. Department of Agriculture (USDA), regarding relief for biofuels industry that was in the Consolidated Appropriations Act, 2021. I apologize for the delayed response.

We understand your concerns that the development, implementation, and rollout of a program to aid the biofuels industry has been taking a while, but we want to assure you that the program will be implemented this year. While it is a priority for the Administration, there are many other provisions that USDA needs to work through from both the Consolidated Appropriations Act, 2021 and the American Rescue Plan Act, all of which are also important to implement.

USDA's Office of the Chief Economist, Rural Development, and the Farm Service Agency are working together to make sure the program's policies are equitable and will help as many people as possible in the biofuels industry who have been affected by COVID–19.

USDA is committed to delivering financial assistance to farmers, ranchers, and agricultural producers who have been impacted by COVID–19 market disruptions. On March 24, I announced that USDA is establishing new programs and efforts to bring financial assistance to farmers, ranchers, and producers who felt the impact of these market disruptions. The new initiative, USDA Pandemic Assistance for Producers, will reach a broader set of producers than in previous COVID–19 aid programs. I've asked my team to review support for biofuels producers and we are working towards an update of programs by Labor Day.

We will continue to provide the latest information about the Pandemic Assistance for Producers initiative on *www.farmers.gov.* The site will have timely updates and announcements for producers.

Again, thank you for writing. A similar response has been sent to your colleagues.

Sincerely,

Hon. THOMAS "TOM" J. VILSACK,
Secretary.

LETTER 3

September 22, 2021

Hon. JOSEPH R. BIDEN,
President,
The White House,
Washington, D.C.

Dear President Biden,

We are deeply disappointed by the rumors that indicate your Administration is reversing course on its promises as it relates to upholding the Renewable Fuel Standard (RFS). During your campaign, just over a year ago, you said that former President Donald J. Trump "could have made explicit his imperative to stand with American farmers by reversing harmful waivers and setting strong levels for 2021,"[1] and yet, we understand that the forthcoming Renewable Volumes Obligation (RVO) will cut the demand for more combined gallons of ethanol than all gallons cut due to Small Refinery Exemptions (SREs) issued by the prior Administration.

If your Administration makes the unprecedented move to reopen the finalized 2020 RVO, and strip the demand for billions of gallons, the industry will certainly be devastated. As you stated, "Lip service won't make up for nearly 4 years of retroactive damage that's decimated our trade economy and forced ethanol plants to shutter." If these rumors are correct, demand for over 5 billion gallons of renewable, clean fuels will be lost.

Biofuels production is a major piece of the rural economy in our districts, therefore, we strongly urge you to direct your EPA to reconsider the rule to ensure that your Administration makes good on these promises to "fight for family farmers and revitalize rural economies . . . by ushering in a new era of biofuels."

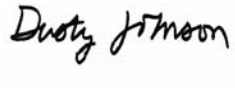
Both oil refiners and ethanol refiners were hurt by decreased demand due to the COVID–19 pandemic, and while we hope that markets will continue to rebound, it is now more important than ever to uphold the law and ensure our domestic biofuels producers have certainty through fulfilling the statutory obligation of 15 billion gallons of conventional ethanol, annually, along with a strong overall RVO.

Given the challenges facing our farmers from all sides on this issue, it is imperative that your Administration choose to stand with American farmers. We stand ready to work with you to ensure that our biofuels producers are once again prioritized through a strong RVO, and that the law is upheld. Thank you for your attention to this request.

Sincerely,

Hon. RODNEY DAVIS,
Member of Congress

Hon. ADRIAN SMITH,
Member of Congress



Hon. DUSTY JOHNSON,
Member of Congress

Hon. ASHLEY HINSON,
Member of Congress

Hon. MICHELLE FISCHBACH,
Member of Congress

Hon. RANDY FEENSTRA,
Member of Congress

Hon. DARIN LAHOOD,
Member of Congress

Hon. TOM EMMER,
Member of Congress

Hon. ANN WAGNER,
Member of Congress

[1] *https://joebiden.com/2020/09/15/statement-by-vice-president-joe-biden-on-need-to-stand-with-farmers-and-biofuel-producers-after-donald-trumps-latest-insult-to-ethanol-industry/*.

Hon. TRACEY MANN,
Member of Congress

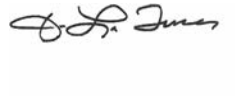
Hon. MARIANNETTE MILLER-MEEKS,
Member of Congress

Hon. JIM HAGEDORN,
Member of Congress

Hon. VICKY HARTZLER,
Member of Congress

Hon. JAMES COMER,
Member of Congress

Hon. RON ESTES,
Member of Congress

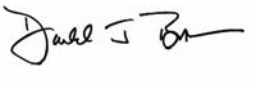


Hon. JAKE LATURNER,
Member of Congress

Hon. JAMES R. BAIRD,
Member of Congress

Hon. ADAM KINZINGER,
Member of Congress

Hon. SAM GRAVES,
Member of Congress



Hon. DON BACON,
Member of Congress

Hon. BLAINE LUETKEMEYER,
Member of Congress

Hon. MIKE BOST,
Member of Congress

SUPPLEMENTARY INFORMATION SUBMITTED BY EMILY SKOR, CHIEF EXECUTIVE OFFICER, GROWTH ENERGY

Insert

Mr. BAIRD. Thank you very much, and it looks like I have about 10 seconds left, so I yield back my time.

But Ms. Skor, I was going to ask about the reduction in greenhouse gas emissions by 46 percent by using ethanol, but I am out of time, and so, I yield back.

To meet the challenges in reducing carbon emissions from our transportation sector, biofuels are an immediately available, renewable liquid fuel which reduce greenhouse gas emissions (GHGs) from light- and heavy-duty vehicles.

A January 2021 study conducted by Environmental Health and Engineering, Inc., led by Harvard Adjunct Professor David MacIntosh, found that GHGs from corn-based ethanol are 46% lower than gasoline.[1] Additionally, a study by Growth Energy showed that a nationwide transition from E10 to E15 would lower GHGs by 17.62 million tons annually, the equivalent of removing 3.85 million vehicles from the road.[2]

We need more biofuels like ethanol, which have the potential to do even more to reduce the carbon intensity of transportation with the right combination of policy and marketplace certainty. With this in mind, we ask that you continue your strong

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[1] *https://iopscience.iop.org/article/10.1088/1748-9326/abde08*.†

Editor's note: references annotated with † are retained in Committee file.

[2] *http://www.airimprovement.com/reports/national-e15-analysis-final.pdf*.†

support for the biofuels industry so we can continue to innovative and de-carbonize our transportation fleet.

EMILY SKOR,
CEO, Growth Energy.

SUBMITTED LETTER BY SARAH GALLO, VICE PRESIDENT, AGRICULTURE AND ENVIRONMENT, BIOTECHNOLOGY INNOVATION ORGANIZATION

November 16, 2021

Hon. ANTONIO DELGADO,
Chairman,
Subcommittee on Commodity Exchanges, Energy, and Credit,
House Committee on Agriculture,
Washington, D.C.;

Hon. MICHELLE FISCHBACH,
Ranking Minority Member,
Subcommittee on Commodity Exchanges, Energy, and Credit,
House Committee on Agriculture,
Washington, D.C.

Dear Chairman Delgado, Ranking Member Fischbach, Members of the Subcommittee:

The Biotechnology Innovation Organization (BIO) is pleased to submit a statement for the record to the United States House of Representatives Committee on Agriculture Subcommittee on Commodity Exchanges, Energy, and Credit hearing on *A Look at the Renewable Economy in Rural America.*

Introduction

BIO[1] represents 1,000 members in a biotech ecosystem with a central mission—to advance public policy that supports a wide range of companies and academic research centers that are working to apply biology and technology in the energy, agriculture, manufacturing, and health sectors to improve the lives of people and the health of the planet. BIO is committed to speaking up for the millions of families around the globe who depend upon our success. We will drive a revolution that aims to cure patients, protect our climate, and nourish humanity.

A Look at the Renewable Economy in Rural America

BIO applauds the Subcommittee for examining how the Renewable Economy can benefit Rural America. As the Committee and Congress begin work on the 2023 Farm Bill, it will be critical to examine policies to combat climate change, strengthen the renewable economy, create jobs, and maintain our supply chains.

Growing the renewable economy will require Congress to lead with science and U.S. innovation. We must incentivize the adoption of innovative, sustainable technologies and practices; and streamline and expedite regulatory pathways for breakthrough technology solutions. Investment in and deployment of cutting-edge technologies will be crucial to ensure farmers, ranchers, sustainable fuel producers, and manufacturers are able to respond to climate change and maintain the U.S.'s global leadership in agriculture. This includes removing barriers and assisting beginning and socially disadvantaged farmers and ranchers to access and utilize these technologies, so all producers can adapt to the challenges ahead. By accelerating and deploying innovation, American agriculture can be resilient, self-sustaining, and drive our economic recovery.

BIO supports legislative action that that catalyzes resilient and sustainable biobased economies. Policy should use science-based targets to increase the use of biobased manufacturing and low-carbon fuels. Science-based policy will promote resilient and sustainable supply chains across economic sectors including translating sustainability to best practices in all bioindustries. This will enable U.S. agriculture to combat climate change while producing enough food, feed, fuel, and fiber for a growing world.

To aid the Subcommittee in its work and provide more background on these technologies and the innovative breakthroughs that can reduce greenhouse gas emissions throughout agricultural supply chains, attached is BIO' *Biotech Solutions for Climate Report,*[2] which examines biotechnology's contributions to addressing the climate crisis. This report highlights how biotechnology can achieve at least 3 billion

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[1] *https://www.bio.org/.*
[2] *https://www.bio.org/sites/default/files/2021-04/Climate%20Report_FINAL.pdf.*

tons of CO_2 equivalent mitigation annually by 2030, by delivering vital climate solutions in four key areas:

- Producing sustainable biomass feedstock
- Empowering sustainable production
- Developing lower carbon products
- Enhancing carbon sequestration

Conclusion

By bolstering existing technologies and investing in emerging biotechnologies the agricultural value chain could provide transformative greenhouse gas benefits in a range of sectors, to the benefit of Rural America's renewable economy.

BIO is committed to working with the Subcommittee to support policy that advances pioneering technology breakthroughs. With science we can return our nation and the world to health and prosperity by taking bold and drastic action to address the climate crisis.

Sincerely,

SARAH GALLO,
Vice President, Agriculture and Environment,
Biotechnology Innovation Organization.

ATTACHMENT 1

Biotech Solutions for Climate Report

Executive Summary

Examining biotechnology's contributions to addressing the climate crisis

> "Climate change is one of the greatest public policy challenges facing this generation."

New approaches are required at almost every level of the economy. Biotechnology has the potential to be a transformative asset in this struggle, offering vital contributions to near-term greenhouse gas (GHG) reductions and revolutionary tools to avert catastrophic climate change in the longer term. New biotech tools, including gene editing and synthetic biology, can be transformative climate solutions in key emerging industry sectors. Policies supporting the development and deployment of biotech climate solutions should be part of any government effort to address climate change.

Biotechnology can achieve at least 3 billion tons of CO_2 equivalent mitigation annually by 2030, using existing technologies, and emerging biotechnologies could have transformative GHG benefits in a range of industrial sectors. Biotechnology can deliver vital climate solutions in four key areas:

- Producing sustainable biomass feedstock
- Empowering sustainable production
- Developing lower carbon products
- Enhancing carbon sequestration

Producing Sustainable Biomass Feedstock

Substituting sustainably produced biomass feedstocks for fossil feedstocks is a critical component of de-carbonizing the U.S. economy because it leverages the capacity of photosynthesis to remove carbon from the atmosphere. Biomass substitution has provided vital near-term reductions in the carbon intensity of transportation fuels and a rapidly growing array of consumer products. In several key markets, such as aviation fuels, biobased alternatives offer the only viable path to GHG reductions. Biotechnology is being deployed to develop and utilize a range of next-generation sustainable biomass feedstocks to expand the availability and further reduce the carbon intensity of biofuels and biobased products. Future climate gains from biomass will depend critically on the carbon footprint of biomass feedstock production.

Biotech innovations in sustainable biomass production are also transforming the broader agriculture sector. Agriculture accounts for roughly 10% of total U.S. GHG emissions.[1] The vast majority of these emissions are nitrogen emissions from fertilizer and soils and methane emissions from livestock. Biotech is being deployed to tackle both issues.

Key Findings:

- Biofuels from agricultural or municipal waste and dedicated energy crops such as algae, switchgrass, hybrid poplar and Miscanthus have achieved GHG reductions of up to 80% *versus* petroleum with current technology.[2]
- Continued improvements in feedstock production, conversion efficiency, and co-products are expected to yield pathways with negative carbon scores.[3]
- Biotechnology is being deployed to radically reduce agricultural nitrogen emissions: first, by introducing nitrogen-fixing microorganisms, known as agricultural (ag) biologicals, to the soil; and second, by using plant biotechnology to engineer plants to better utilize soil nitrogen. Biotech solutions could reduce nitrous oxide emissions from agriculture by more than 150 million metric tons of carbon equivalent.
- Ag biologicals and plant biotechnology are being similarly leveraged to enhance soil carbon sequestration through introduction of carbon-fixing soil microbes and larger plant root systems. Ag biologicals and plant biotechnology could enhance soil carbon sequestration by up to 600 million metric tons per year if widely deployed.
- Biotechnology is reducing methane emissions from livestock through new animal feeds and feed ingredients, more efficient animals, and solutions for processing and reusing animal waste.
- Plant biotechnology will be critical to continued agriculture sustainability gains, including improvements in crop yields, photosynthetic efficiency, and climate resiliency.
- Together, biotech solutions have the potential to reduce agriculture sector GHG emissions by nearly 1 billion metric tons (1 gigaton) annually—or the equivalent of GHG emissions from more than 100 million U.S. homes.

Empowering Sustainable Production

Manufacturing of everyday products, like apparel, plastics, packaging, carpet and cosmetics, is a major greenhouse gas emitter, responsible for 22% of total GHG emissions.[4] Biotechnology can dramatically reduce these emissions by making their building blocks from renewable feedstocks rather than fossil fuels; in many cases, biology allows drop-in replacements of existing building blocks, enabling faster adoption throughout our economy with homegrown solutions. New biotech tools, including gene editing and synthetic biology, offer the potential for transformative climate solutions in key emerging industry sectors. Biotech offers a sustainable model for manufacturing in the 21st century.

Key Findings:

- Biomanufacturing—the use of enzymes and microorganisms in manufacturing—can reduce GHG emissions 80% or more relative to traditional chemical routes for a variety of chemicals and consumer products.[5]
- CRISPR and other gene editing tools have dramatically increased the speed and reduced the cost of genetic engineering and are being deployed to tackle a range of global challenges, including climate change.
- Biology-based parallel computing and DNA data storage have the potential to cut the energy and carbon footprints of computing and data storage—sectors expected to account for 14% or more of global GHG emissions by 2040 [6]—by 99% or more *versus* current technology.[7]
- Biological sensors, coatings and ingredients can substantially reduce food and feed waste, which is responsible for roughly seven percent of total global GHG emissions.[8]

Devloping Lower-Carbon Products

As awareness of the climate crisis expands, consumers are increasingly demanding lower-carbon options and more sustainable replacements for existing products. This means finding low-emission alternatives that provide the same level of performance, durability and cost-effectiveness as mature fossil-based systems. Biotechnology allows for the production of low-carbon consumer products through the substitution of biomass or other recycled carbon feedstocks and by enabling more efficient, biologically-based production, satisfying an increasingly important market segment while reducing emissions.

Key Findings:

- First-generation biofuels have reduced U.S. transportation sector GHG emissions by 980 million tons over the past thirteen years,[9] equivalent to taking roughly 16 million vehicles off the road, or 19 coal-fired power plants offline,

for that period.[10] Biotech innovations in feedstocks, processing, co-products, and carbon recycling continue to lower their carbon intensity.

- With lifecycle GHG reductions of 80% or more *versus* petroleum, next-generation feedstocks will more than double the transportation GHG emissions reductions achieved by first-generation biofuels and are poised to deliver carbon-negative transportation solutions.
- Biobased products produced from biomass or biologically recycled waste gases added $459 billion to the U.S. economy in 2016[11] and are built from carbon that would otherwise reside in the atmosphere, creating a pivotal pathway for atmospheric carbon removal.
- Biobased plastics and polymers, such as PLA, PHA, and BDO have achieved lifecycle GHG reductions of up to 80% *versus* their petroleum-based counterparts.[12] A rapidly growing list of new biobased chemical building blocks is now in development.
- Biotechnology is lowering the carbon footprint of animal products and making possible a growing array of sustainable, low-carbon options for meat and animal products through:
  - Plant-based and cultured meats with up to 89% lower lifecycle GHG emission.[13]
  - Algae and microbial feed ingredients that reduce enteric methane emissions from ruminant animals by 68% or more,[14–15] avoiding the equivalent of up to 140 million metric tons of carbon annually.
  - Other biotech ingredient options for fish feed that reduce its carbon footprint by up to 30%.[16]
  - Anaerobic digestion of animal waste, with the potential to reduce U.S. GHG emissions by 151 $MTCO_2$ eq. annually by 2050 using current technology.[17]

Enhancing Carbon Sequestration

A broad scientific consensus exists that reducing carbon emission alone will be insufficient to avert catastrophic climate change. Almost every model of a successful stabilization of global temperatures includes a substantial component of carbon dioxide removal from the atmosphere as well.[18] Biotechnology has multiple critical roles in achieving the needed carbon removal.

Key Findings:

- Biological carbon capture is the most feasible near-term pathway to meaningful atmospheric carbon removal. Development of thermochemical systems for point-source and direct-air capture remains an important technology pursuit, but photosynthesis and other biological pathways remain the only established mechanisms for carbon capture on a scale sufficient for carbon removal.
- Bioenergy with Carbon Capture and Sequestration (BECCS) could cost-effectively remove over 700 million metric tons of carbon per year by 2040, or more than half the emissions from all U.S. coal power plants.[19]
- Algae and other microbial carbon capture systems applied to biomass energy or other biorefinery systems offer one of the most carbon-negative climate solutions available.
- Suitable land and other infrastructure exists to deploy algae-based carbon capture systems at more than 500 power plants and ethanol facilities in the U.S. These systems would have a potential to capture more than 200 million tons of CO_2 annually.[20]

Conclusion

Biotechnology is a crucial enabling technology to combat climate change. It offers gigaton solutions from existing technologies and potentially transformative solutions in multiple sectors of the economy. Current and future biotechnology innovations will be needed to achieve a zero-carbon economy and play a key role in carbon capture and sequestration to take us beyond zero. Policies supporting the development and deployment of biotech climate solutions should be part of any government effort to address climate change.

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ATTACHMENT 2

Biotech Solutions for Climate Report

Examining biotechnology's contributions to addressing the climate crisis

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Introduction

"Climate change is one of the greatest public policy challenges facing this generation."

The rapid accumulation of anthropogenic carbon dioxide in the atmosphere is already altering natural climate [1] and biological systems, resulting in abnormally destructive wildfires, storms, rainfall patterns and the spread of infectious disease. It is increasingly clear that the historical, fossil fuel-based models of carbon, energy and material cycling through the economy are incompatible with maintaining a hospitable environment. Humanity will need to bring every tool it has to bear on this critical challenge. New approaches are required at almost every level of the economy. Biotechnology has the potential to be a transformative asset in this struggle.

Biotechnology is technology based on biology. Biotechnology applications touch most aspects of modern life, from agriculture to manufacturing to medicine. In the context of climate change, biotechnology offers solutions in four key categories:

- Producing sustainable biomass feedstock
- Empowering sustainable production
- Developing lower carbon products
- Enhancing carbon sequestration

Biotechnology offers vital contributions to near-term greenhouse gas (GHG) reductions and revolutionary tools to combat climate change in the longer term. Policies supporting the development and deployment of biotech climate solutions should be part of any government effort to address climate change. This report reviews the current contributions of biotechnology to greenhouse gas (GHG) reductions and identifies the emerging biotech solutions with the greatest potential to avert, and reverse, catastrophic climate change. We focus on four main areas:

Producing Sustainable Biomass Feedstock. For most of human existence, our lives were based on the products of renewable biomass—plants and other living material. In the past 150 years, much of our economy has come to depend on petroleum and other non-renewable resources. The environmental consequences of this transition from renewable resources to non-renewable resources are well documented.[2]

Biotechnology has developed more sustainable, biobased alternatives for many products, including fuels, polymers, and other chemicals. The U.S. consumed over 7.5 billion barrels of petroleum in 2019,[3] some of which was turned into plastic; as much as 35 million tons of plastic ended up in waste streams annually in recent years.[3–4] More sustainable options have been developed over recent decades, but ultimately they still require a material input. Biobased alternatives offer the potential for significantly reduced carbon footprints and environmental benefits compared to the traditional systems they displace, and these alternatives depend on broad availability of sustainable biomass feedstock. At present, there are concerns that not enough biomass will be sustainably available to meet growing demand. Biotechnology is rapidly reducing the carbon footprint of feedstock production by enabling new, sustainable ways to produce usable biomass, improving yields on existing crops, developing scalable, low-input production systems, and finding new ways to utilize biomass that would otherwise be waste.

Empowering Sustainable Production. Manufacturing is a major greenhouse gas emitter, from industrial boilers, chemical production, and the release of high-warming-potential gases like methane or fluorinated hydrocarbons. Biotech empowers a variety of options to reduce emissions from these processes, by reducing the need for energy inputs, facilitating more efficient material processing, or replacing high-warming-potential gases. Biotechnology has also enabled renewable natural gas systems that can displace the fossil-based methane today, simply by switching the source of the gas. The U.S. manufacturing sector is responsible for 22% of total GHG emissions,[5] and while no single technology or solution can single-handedly solve the problem, biotech enables opportunities for lower-emission production across many sectors.

Developing Lower-Carbon Products. As awareness of the climate crisis expands, consumers are increasingly demanding lower-carbon options and more sustainable replacements for existing products.[6] This means finding low-emission alternatives that provide the same level of performance, durability and cost-effectiveness as mature fossil-based systems. Biotechnology allows for the production of low-carbon consumer products through the substitution of biomass or other recycled carbon feedstocks and by enabling more efficient, biologically based production, satisfying an increasingly important market segment while reducing emissions at the same time.

Enhancing Carbon Sequestration. While there is a lot of uncertainty about what a sustainable future may look like, several features are common across all likely scenarios. One of these is the deployment of massive amounts of carbon capture and sequestration (CCS), which converts carbon to a form that does not contribute to climate change or stores it underground. CCS cannot be the sole or even the primary solution to climate change, but it will make a critical contribution. Biotechnology has a key role in advancing CCS techniques, making it more scalable, reliable and cost-effective.

2 Technologies

In this section, we review biotechnology applications to climate mitigation in four broad categories: products; agricultural inputs and climate services; new biotech tools and bio-industrial manufacturing; and plant and animal biotechnologies.

2.1 Products

2.1.1 Advanced Biofuels

Liquid biofuels were one of the earliest biotechnology products to be deployed at scale in the U.S. for the purpose of achieving greenhouse gas (GHG) emission reductions. In the early 21st century, production mostly took the form of the first-generation biofuels ethanol and biodiesel, derived from feedstocks such as corn and vegetable oils. Concerns about competition for these feedstocks with the food and animal feed sectors prompted the development of second-generation liquid biofuels that are produced from low-carbon-intensity (CI) feedstocks, such as lignocellulosic biomass.

Existing first-generation biofuels pathways rely heavily on the fermentation of starch-rich feedstocks to ethanol and, to a lesser but still substantial extent, the transesterification or hydrotreating of vegetable oils to biodiesel or renewable diesel, respectively. Fermentation is one of the oldest examples of biotechnology, having been mastered by humans thousands of years ago for the purpose of producing alcoholic beverages. Glucose is easily fermented by the microorganism *Saccharomyces cerevisiae* to yield a diluted form of ethanol known in the industry as "beer". Distillation of this intermediate produces a high-proof ethanol that is then blended with gasoline for use in motor vehicles. Most gasoline in the U.S. today contains 10% ethanol, with 15% blends increasingly available.[7]

Advances in biotechnology have enabled U.S. ethanol producers to achieve substantial efficiency improvements in recent decades that have enabled the volume of first-generation ethanol obtained from a bushel of corn to increase by more than 10% between 1982 and 2014.[8] Milling improvements based on improved knowledge of corn kernel composition increased conversion efficiency, reducing the amount of corn required.[9] Likewise, a better understanding of yeast biology led to ethanol yield optimization via temperature-controlled fermentation.[10] And advanced fractionation techniques have allowed for greater yield of co-products, such as distillers dry grains (DDGS), a key animal feed ingredient. Together these advances have improved the process economics and sustainability of the pathway by reducing costs and waste. The EPA estimates them to have resulted in reductions to ethanol's carbon intensity in excess of 10%.[11] A shift to more sustainable growing practices, driven by a desire to capture the compliance value of low-carbon programs such as the California Low Carbon Fuel Standard (LCFS), is further reducing the carbon intensity of first-generation fuels. And the prospect of deploying carbon capture technology at ethanol plants, detailed in section 2.2.2, could reduce the carbon footprint of first-generation ethanol by an additional 40%.[12]

Biotechnology has also made a wide range of low-carbon intensity feedstocks available for utilization by biofuel producers. Glucose is a fundamental building block of plants, and plants possess multiple defense mechanisms to protect themselves from yeast and other microorganisms that consume glucose. Plants' glucose content takes the form of the polysaccharide cellulose that is not digestible by most living things (one notable exception being termites). Other simple sugars such as arabinose and xylose comprise a second type of major polysaccharide that plants contain, hemicellulose. Plants are further protected by a third compound with antimicrobial properties, lignin, that is cross-linked with cellulose and hemicellulose to protect them against attack by microorganisms. These traits allow plants to thrive in the wild but have also posed a major hurdle to their use as a second-generation biofuel feedstock by inhibiting their conversion to ethanol via fermentation.

Recent progress in the development of biocatalysts and engineered microorganisms has made possible the production of ethanol from second-generation feedstocks such as grasses, shrubs, and other dedicated energy crops. The enzymatic hydrolysis pathway employs biocatalysts to break cellulose and hemicellulose down to glucose and other constituent sugars. The glucose is converted to fuel ethanol in the same manner as corn glucose. Microorganisms that are naturally able to ferment glucose have been engineered to make them capable of also fermenting simple sugars derived from hemicellulose to ethanol, improving both yields and efficiencies of lignocellulosic biofuel production.

An early commercial application of this pathway utilizes the lignocellulose that is found in small quantities in corn kernels to produce ethanol. Biotech companies POET, Syngenta, and Enogen, among others, have begun adding corn kernel fiber conversion units to first-generation ethanol plants, potentially increasing ethanol yield per bushel of corn by nearly 10%.[13]

The full potential of cellulosic biofuel to mitigate climate change will depend on broad deployment of cellulosic technology to agricultural residues, municipal solid waste (MSW), and dedicated energy crops. An initial wave of cellulosic ethanol biorefinery construction occurred following the 2009 implementation of the Federal Renewable Fuel Standard (RFS) program. Leading first-generation ethanol producers such as POET, LLC, have partnered with leading biotech innovators to build first-of-a-kind cellulosic biofuel plants in the U.S., Europe, and South America, but low oil prices, policy obstacles, and technology challenges have limited global production volumes.

Advances in biotechnology have expanded the supply of feedstocks available to biodiesel and renewable diesel, two of the major success stories in sustainable transportation. Biodiesel (BD) is produced via the transesterification process in which lipid feedstocks are reacted with methanol to yield a fatty acid methyl ester (FAME) that can be blended into conventional diesel, without needing any modification to the engine. Renewable diesel (RD) is made by hydrotreating the same kind of lipid feedstocks, in a process very similar to parts of conventional oil refining; it has performance characteristics like those of diesel fuel, passes the same product specifications and can be used in any diesel engine at any concentration. Historically most U.S. BD and RD have been produced from soybean oil.[14] The need for new feedstocks has grown over the last decade, however, as production has expanded and policies such as California's Low Carbon Fuel Standard (LCFS) have incentivized the use of second-generation low-carbon intensity feedstocks. Some of these newer feedstocks are waste products that are not as easily converted to biodiesel as first-generation feedstocks. Biocatalysts have been developed that improve the conversion efficiencies and performance characteristics of biodiesel that is yielded from waste

feedstocks,[15] allowing for more of them to be converted to low-carbon transportation fuel.

Biotechnology has also enabled the production of novel low-carbon fuels that complement existing ethanol and biodiesel production. First-generation biofuels have a limited ability to widely displace existing fossil fuels due to infrastructure compatibility hurdles. The U.S. only allows ethanol blends of up to 15% by volume with gasoline in non-flex fuel vehicles[16] and most diesel engine warranties only cover biodiesel blends of up to 20% by volume.[17] Moreover, neither is capable of displacing specialized fossil fuels such as aviation fuel. Technological advances have yielded a new category of "drop-in biofuels"—so named for their ability to utilize the existing refined fuels infrastructure—that have an even greater de-carbonization potential.

Biobutanol (butanol derived from biomass) was one of the first biofuels to gain attention for its drop-in properties, as it chemically behaves more like a hydrocarbon than ethanol does. While actually an intermediate to renewable hydrocarbons (see below), biobutanol's high energy equivalence ratio compared to ethanol and ability to be blended with gasoline at rates of up to 16% by volume allow it to displace correspondingly larger volumes of gasoline.[18] Biobutanol is produced via fermentation from the same simple sugars as in ethanol production. Some biofuel producers have genetically modified ethanol yeast to instead produce isobutanol. There are also pathways that utilize bacteria for the conversion rather than yeast. Biobutanol can also be produced via engineered microorganisms from the carbohydrates in some microalgae strains that remain after lipids have been extracted, allowing for microalgae to serve as a simultaneous feedstock for both biobutanol and biomass-based diesel.[19]

More recently, biobutanol has attracted interest as a key step towards production of the renewable hydrocarbon fuels isooctane and sustainable aviation fuel SAF). Unlike biobutanol, which is an alcohol, biobased isooctane and SAF are hydrocarbons with performance characteristics that are very similar to their fossil counterparts (isooctane is an important blending component in gasoline). They are true drop-in biofuels in that they can be used in the same quantities as the fossil fuels that they displace before encountering infrastructure constraints.

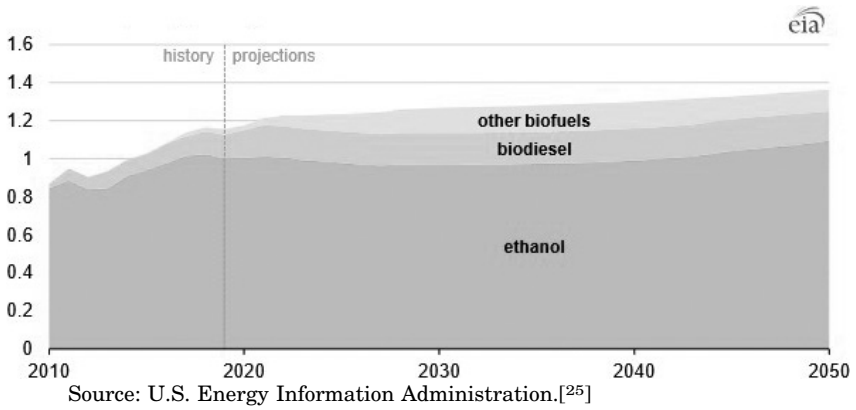
Biotechnology has also enabled the production of SAF directly from biomass via fermentation. Historically the conversion of biomass to hydrocarbons via fermentation has been limited by the presence of oxygen in biomass that has caused microorganisms to favor oxygen-containing products (*e.g.,* ethanol, butanol). Metabolic engineering has been employed to improve the yield of the specific hydrocarbon, kerosene, that comprises a common form of aviation fuel by increasing the selectivity of fermenting microorganisms.[20] The microorganisms are able to convert sugars derived from a variety of feedstock types to SAF.[21] Hydrocarbons have hydrophilic properties, allowing those produced in this manner to avoid the need for the energy-intensive distillation step that is required when producing fuel alcohols.

Biofuels currently supply approximately 12% of U.S. on-road transportation fuel.[22] Ethanol and biodiesel currently comprise the large majority of U.S. biofuels consumption. Production of second-generation biofuels is expected to increase rapidly during the early 2020s, however, as the new feedstocks and pathways made possible by biotechnology breakthroughs are commercialized (see *Figure 1*).[23] A combination of factors is responsible for this development. First, the COVID–19 pandemic has seriously disrupted demand for fossil fuels in the U.S. transportation sector, in turn limiting demand for biofuels such as ethanol that have restrictive blend limits. Second, policies such as the Federal revised Renewable Fuel Standard (RFS2), the California Low Carbon Fuel Standard (LCFS) and the Oregon Clean Fuels Program incentivize second-generation biofuels, with their lower carbon intensities, over first-generation biofuels (and both over fossil fuels). Third, whereas the last decade's rapid growth in first-generation biofuels production has slowed due to supply constraints, second-generation feedstocks remain underutilized.[24]

Figure 1: Estimated U.S. biofuel production volumes by type of fuel, 2010–2050.

U.S. Production of Selected Biofuels in AEO2020 Reference Case (2010–2050)

(million barrels per day (MMb/d))



Source: U.S. Energy Information Administration.[25]

The carbon intensities of biofuels vary widely depending on feedstock(s), conversion processes, and the geographic length of the supply chain. California publishes detailed carbon intensities of the biofuels that participate in its LCFS for both broad biofuel categories as well as individual producers. Ethanol, which has historically been the primary source of biofuels under the LCFS by volume, has achieved average GHG emission reductions compared to gasoline of between 32% and 41% in recent years.[26] Ethanol from waste, or dedicated energy crop feedstocks, have achieved GHG reductions of up to 80% with current technology.[27] Continued improvements in feedstock production, conversion efficiency, and co-products are expected to yield pathways with negative carbon scores.[28]

Similarly, biodiesel has achieved average GHG emission reductions compared to diesel fuel of between 69% and 74% over the same period, although individual reduction values range from as low as 50% to over 90% depending on the feedstock used.[29] In both cases, California reports the lowest carbon intensities for those biofuels that are produced from waste feedstocks, illustrating the value that biotechnology has provided by helping to make such feedstocks usable by biofuels producers.

Biobutanol from lignocellulosic biomass has yet to achieve commercial-scale production volumes and does not have published LCFS carbon intensity values as a result. Independent life cycle assessments estimate a GHG emission reduction for the biofuel compared to gasoline of approximately 66%, which is comparable to ethanol from lignocellulosic biomass.[30] Likewise, SAF from biobutanol is estimated to achieve GHG emission reductions compared to petroleum aviation fuel of between 60% and 75% depending on the choice of feedstock and conversion inputs.[31]

GHG emissions are not the only form of air pollution that the use of biofuels reduces. Emissions of criteria pollutants such as carbon monoxide, particulate matter, and sulfur dioxide have a direct impact on human health, causing air pollution to be one of the main risk factors causing non-communicable diseases globally.[32] The combustion of commonly used biofuels in both blended and unblended forms has been found to reduce many, if not all, of the criteria pollutants that are emitted by the combustion of petroleum fuels.[33–34]

Gevo Case Study

Gevo is an advanced renewable fuel producer that converts renewable energy to energy-dense liquid hydrocarbons by transforming renewable energy into low-carbon transportation fuels. This next generation of renewable premium gasoline, jet fuel and diesel fuel has the potential to achieve net zero carbon emissions, addressing the market need of reducing GHG emissions with sustainable alternatives while continuing to utilize current infrastructure and vehicles.

The company originally converted an existing dry-mill corn ethanol facility to a commercial-sized scaled up facility in Luverne, Minnesota. The converted facility utilizes corn starch as feedstock. While corn-based biofuels have not historically been credited with large reductions to carbon intensity relative to gasoline, Gevo employs an integrated approach to carbon intensity reductions that maximizes the environmental and sustainability potentials from agricultural systems, while creating innovative solutions to convert the feedstocks into energy-dense hydrocarbons.

In January 2021, Gevo announced a new project, planned for construction at Lake Preston, South Dakota, to be named "Net-Zero 1." Gevo expects that Net-Zero 1 would have the capability to produce liquid hydrocarbons that when burned have a net-zero greenhouse gas footprint.[35] Net-Zero 1 is expected to have a capacity of 45 million gallons per year of hydrocarbons for gasoline and jet fuel and will produce more than 350 million pounds per year of high-protein feed products for use in the food chain. In addition to feed and fuel, the facility will produce enough renewable natural gas to be self-sufficient for production process needs. The facility will also generate renewable electricity with a combined heat and power system and integrate additional renewable power production utilizing wind energy.

Gevo's integrated approach utilizes de-carbonization practices across the entire supply chain. It begins by working with the farmers who employ best farming practices that maximize soil carbon sequestration and minimize GHG emissions during the planting, growing, and harvesting stages.[36] The partnership with farmers involves the active tracking and monitoring of the feedstock suppliers to ensure that best practices are encouraged and in the future can be incentivized for the purpose of consistently minimizing feedstock carbon intensity.

Gevo also conducts experimental trials to identify additional feedstock de-carbonization routes such as the use of manure in place of nitrogen fertilizer application, enhanced soil carbon sequestration via reduced soil tillage practices, and improved crop yields via microbial soil solutions. The company estimates that its corn feedstock has a carbon intensity that is at least 50% lower than the U.S. average.[37]

Because of the low-carbon-footprint feedstocks, the sustainable agricultural practices used to produce feedstock, and the use of renewable energy for the production processes—much of which is expected to be generated on site—the hydrocarbon fuel products produced at Net-Zero 1 have the potential to achieve net-zero greenhouse gas emissions, as measured across the whole of the life cycle, based on Argonne National Laboratory's GREET model. The GREET model takes into account emissions and impacts "cradle to cradle" for renewable resource based fuels, including inputs and generation of raw materials, agriculture practices, chemicals used in production processes of both feedstocks and products, energy sources used in production and transportation, and end fate of products.

Gevo's Luverne facility also makes extensive use of other sources of renewable energy to reduce the carbon intensity of its production process. The production of biofuels such as isobutanol from corn uses process heat and electricity that have historically been obtained from fossil fuels, such as coal and natural gas. And Gevo has installed wind turbines to generate renewable electricity. Minnesota has abundant access to low-cost wind power and Gevo pays "about the same" price for electricity as it did prior to the installation of the wind capacity.[38] In 2019, Gevo announced its intention to utilize renewable natural gas that is produced from dairy manure in place of the fossil natural gas it used to produce process heat in the past.[39] In both cases, Gevo has been able to take advantage of local renewable energy resources that are supplied directly to the Luverne facility via transmission line and natural gas pipeline.

2.1.2 Renewable Chemicals and Biobased Products/Materials

Fossil-derived chemicals and products are a key future driver of petroleum consumption.[40] The chemicals sector (known as petrochemicals when derived from fossil feedstocks) accounts for a wide variety of common products, including plastics, synthetic rubber, solvents, fertilizers, pharmaceuticals, additives, explosives, and adhesives.[41] They differ from fossil fuels in that their consumption does not normally cause GHG emissions via combustion. They are still produced from fossil fuels, though, especially petroleum and natural gas, and their production incurs both direct and indirect emissions. By one estimate the petrochemicals sector generates 18% of direct industrial GHG emissions, and its production capacity is growing rapidly.[42] The sector is also, due to its reliance on fossil fuels, an important source of other forms of pollution that have a detrimental impact on human health, especially in disadvantaged communities.[43] Moreover, many fossil-derived products such as plastics are resistant to degradation and end their useful lives either in landfills or in natural environments as litter.

Biotechnology's contributions to efforts to mitigate the damage caused by fossil chemicals and products generally fall into one of two broad categories: (1) the replacement of these fossil-derived products by non-fossil products, and (2) the replacement of degradation-resistant materials with biodegradable materials. A substantial amount of overlap exists between the two categories due to the novel production pathways and product types that have been developed by the biotechnology industry. The ability of biomass to replace a wide variety of fossil products has greatly benefited from recent biotechnology advances that have enabled the manufacture of products from both categories.[44]

The petrochemical industry is expected to become a primary driver of demand for fossil fuels by 2030.[45] Many advances have been made in the production of the same chemicals and products from biomass or recycled feedstocks rather than fossil feedstocks. One early biobased chemical was developed as an extension of biofuels production, allowing it to utilize existing production capacity. Ethanol obtained from corn and sugarcane, but potentially from lignocellulosic biomass in the future, is easily dehydrated to yield a biobased version of the plastics precursor ethylene.[46] Plastics comprise most of the fossil chemicals market,[47] giving biobased plastics an important role to play in its de-carbonization.

Biotechnology companies have also developed biobased versions of synthetic fibers that are used by the textile industry. Polyester, which is widely employed in the manufacture of textiles and bottles, is usually produced from natural gas and/or petroleum feedstocks. Its building blocks can instead be obtained either from ethanol, as in the production of biobased plastics, or from hydrocarbons that are directly converted from biomass feedstocks.[48–49] In both pathways the resulting fibers are the same as those that are currently produced from fossil feedstocks, making them drop-in biobased products.

Growing concerns over the longevity of plastic waste in the environment have also prompted the development of biodegradable plastics that are capable of decomposing over short timeframes compared to those of traditional plastics. The most common

of these are polylactic acid (PLA) and polyhydroxyalkanoates (PHA). PLA is derived from plant sugars that are naturally fermented by bacteria to yield lactic acid. This lactic acid is then chemically converted to PLA for use as a biobased plastic.[50] PHA is produced via the fermentation of plant sugars (although vegetable oils and even wastewater can also be used) by a different type of bacteria under very specific conditions that promote PHA synthesis.[51] Biobased plastics made from both PLA and PHA are biodegradable under higher-temperature conditions such as those found in industrial composters.

Biotechnology breakthroughs have also been made in the replacement of lesser known but equally important fossil products. Lubricants made from petroleum are in common use throughout the industrial and transportation sectors and, while they represent a small share of a typical refinery's product mix, they are a critical input for many applications (*e.g.,* engine oil). Plant sugars can be fermented by bacteria to yield a chemical that is capable of conversion to biobased versions of the synthetic lubricants that are normally obtained from petroleum.[52] In a similar application biodiesel, which has a high lubricity, is blended with petroleum-derived ultra-low sulfur diesel fuel to improve the latter's low lubricity.[53] Finally, novel medicines and medical treatments are being developed through biotechnology, including those that are personalized to individual patients.[54]

Renewable chemicals and materials provide climate benefits through twin advantages. First, by leveraging biological production platforms, biobased products are frequently less energy-intensive to produce than their petrochemical counterparts. For example, BASF Corporation has developed a biobased home insulation product that results in 66% fewer GHG emissions than its fossil-based alternative.[55] But, perhaps most significantly, whether produced from biomass or waste gases, biobased products are built from carbon that would otherwise reside in the atmosphere, and thus serve as a vital pathway for atmospheric carbon removal.

The direct recycling of GHG emissions, both biogenic and fossil in origin, to create chemicals and fuels has emerged as a notable pathway over the last decade. Landfills and animal waste lagoons are sources of biogenic emissions of the potent GHG methane. Methane is the primary component of natural gas, however, making biogenic methane when captured a potential biobased chemicals feedstock. Biogas captured from landfills and agricultural anaerobic digesters is also directly utilized as fuel for natural gas-powered vehicles.[56] The use of biogas in both applications has especially large climate benefits because it eliminates a source of methane emissions while simultaneously displacing demand for a fossil feedstock (biogas combustion converts methane to the comparatively weaker GHG carbon dioxide).

Finally, biotechnology advances have also enabled fossil GHG emissions to be captured and recycled via a pathway known as carbon capture and utilization (CCU), thereby reducing demand for fossil fuels and the resulting emissions without requiring biomass (see Section 2.2.2). One novel process developed by carbon recycling pioneer LanzaTech utilizes engineered microorganisms to ferment emissions captured from industrial facilities such as steel mills to either fuels or chemicals, depending on the choice of microorganism.[57] While the resulting products are not of biological origin, their climate benefits are substantial and comparable to those of biobased products in that both partially eliminate the need for fossil fuel extraction and serve as sinks for carbon that would otherwise be emitted to the atmosphere.

Like biofuels, the market for biobased chemicals has been constrained by persistent low natural gas and petroleum prices for much of the last decade. The lack of mandates or other policy mechanisms in the U.S. that internalize biotechnology products' climate benefits have made it still more difficult for biobased pathways to compete with fossil pathways. That said, a growing interest by many manufacturers and their consumers in reducing their climate impacts in service of ESG goals has supported an expansion of the U.S. biobased products industry despite these hurdles. One recent analysis estimated the industry's size to be $459 billion in terms of valued added to the U.S. economy in 2016, up from $393 billion in 2014 and $353 billion in 2012.[58] These bioproducts were estimated to displace 9.4 million barrels of petroleum equivalents in 2016. While still smaller than the fossil products sector—the U.S. chemicals industry alone achieved $765 billion in sales in 2017[59]—the U.S. biobased products industry is expected to grow rapidly as state governments and corporations increasingly act to minimize plastic waste, methane emissions, and other forms of pollution.[60]

Biodegradable biobased products have the potential to substantially contribute to climate change mitigation efforts due to their ability to achieve net carbon sequestration under certain production conditions. A life cycle analysis of the biodegradable bioplastic PHB calculated negative GHG emissions for the product when produced from either corn or biogas, with the greatest amount of carbon sequestration occurring when the PHB is produced from existing PHB that has degraded to

biogas.[61] A separate analysis of PHA production determined that the bioplastic has a carbon intensity that is 80% lower than that of fossil-derived plastics even before taking into account the PHA's ability to be recycled following biodegradation.[62] Biobased PLA for use in water bottles has likewise been found to have a substantially lower carbon intensity than fossil-derived plastic.[63] Finally, a comparison of multiple chemicals and fuels pathways determined that products derived from recycled carbon dioxide achieved carbon intensity reductions compared to conventional fossil products despite ultimately being derived from fossil feedstocks.[64]

Biobased products such as renewable chemicals historically have not received as much attention from policymakers as biofuels, due to the lack of direct emissions resulting from their use. That is changing, however, as policymakers in states such as California and New York have implemented economy-wide restrictions on GHG emissions. In addition to disincentivizing the use of fossil feedstocks in energy-intensive manufacturing processes, such policies also encourage entities such as steel mills and refineries to develop new revenue streams via the implementation of CCU technologies.[65] Biotechnology provides a wide range of options for reducing the carbon intensities of many of the biobased chemicals and products upon which the U.S. economy relies.

Danimer Scientific Case Study

Biobased PHA is Danimer Scientific's primary bioplastics product. The company manufactures the polyester at a commercial facility in Winchester, Kentucky, by feeding a bacterium with inexpensive vegetable oil feedstock derived from agricultural oilseed crops such as canola, and soy. In addition to directly displacing the fossil fuels used in the manufacture of conventional plastics, Danimer Scientific's production pathway also provides indirect environmental benefits.

Danimer Scientific obtains vegetable oils via the crushing of oilseeds. The crushing process yields protein-rich byproducts that are employed as a natural fertilizer and livestock feed. The vegetable oils are consumed by soil bacteria that biosynthesize the PHA in a bioreactor. The PHA is then separated from the bioreactor medium, purified, and dried in preparation for conversion to various plastic resins, blending with other biopolymers such as PLA, or bonding with materials such as paper.[66]

Danimer Scientific's biobased PHA possesses performance parameters that are comparable to those of many fossil plastics and are capable of use in many of the same applications, including food preservation and storage and conversion to multiple types of finished resins. Unlike fossil plastics, however, PHA utilizes only renewable feedstocks and is biodegradable. This latter characteristic is an important advantage over fossil plastics at a time of growing concern over land-filling and the widespread presence of non-biodegradable plastic waste in many ecosystems.

Genomatica Case Study

Genomatica has commercialized a more sustainable, biobased technology to make a key ingredient used in apparel, spandex, footwear, and plastics used in electronics and automotive parts. Millions of tons per year of this ingredient, 1,4-butanediol (BDO), are currently produced from fossil-derived feedstocks, resulting in many millions of tons per year of greenhouse gas emissions. By contrast, Genomatica's GENO BDO™ process uses renewable feedstocks—the sugars that come from locally-grown crops such as corn and sugarcane—along with engineered microorganisms and fermentation. The products made with Genomatica's ingredient have 56% lower carbon intensity,[67] and their renewable content is traceable—meaning customers know that the carbon actually came from plants. Genomatica's technology also avoids the use of toxic compounds like formaldehyde, common to fossil processes.

Genomatica's technology has been proven at industrial scale since 2012. Italy-based plastics manufacturer Novamont started production of biobased BDO at a 30,000 ton per year capacity plant in 2016, built with Genomatica's licensed technology. Novamont's BDO has been used in compostable produce bags, mulch film and coffee capsules. BASF has also licensed Genomatica's BDO technology. The Novamont plant is the world's first commercial scale plant to make a widely-used intermediate chemical biologically. Genomatica has received repeated recognition for its innovations, including three EPA Green Chemistry awards, the Kirkpatrick award and ICIS Innovation awards.

2.1.3 Food and Feed Ingredients

According to the 2019 U.N. IPCC *Special Report on Climate Change and Land,* the global food system—including the land and resources to raise animals and grow crops, plus processing, packaging, and transportation—is responsible for up to 19.1 $GtCO_2eq$ annually, or 37% of total net GHG emissions.[68] The report finds that changes in both production and consumption are needed to meet global emissions reduction objectives. Biotechnology offers the potential for substantial emissions reductions at every stage of the food system, including potentially transformative solutions in food and feed ingredients.

Animal products account for the largest segment of food sector emissions. According to the FAO, livestock production accounts for approximately 7.1 $GtCO_2eq$ annually, or 15% of global GHG emissions, and consumes roughly ¼ of available land worldwide, with meat production expected to increase 19%, and dairy production 33%, from 2017 levels by 2030.[69] Solutions that reduce dependence on animals offer the greatest potential for emissions reductions from the food sector. But, given the growing global demand for meat and other animal products, sustainable near-term solutions are also needed for animal agriculture. Biotechnology is playing a leading role in the development of both new low-carbon product choices and technologies to reduce the carbon footprint of animal agriculture.

Plant-Based Proteins and Food Products

A recent analysis found that if Americans opted for nutritionally equivalent plant-based products for their meat (beef, chicken and pork) consumption choices, U.S. GHG emissions would be reduced by 280 million metric tons annually—roughly equivalent to the total emissions of the state of Ohio.[70] Consumer concerns with the carbon footprint of animal agriculture—along with health and animal welfare considerations—are driving strong growth in plant-based proteins and food product choices. Many of the leading options leverage biotechnology.

Impossible Foods, the fourth fastest growing brand in the U.S. in 2019,[71] uses engineered yeast to add heme, an iron-containing molecule found in blood, to its plant-based products to produce a meaty flavor. As of September 2020, Impossible Foods burgers were in 11,000 supermarkets and on the menu of a growing list of national and regional restaurant chains.[72] A 2019 lifecycle analysis of Impossible Foods' burger found a 89% reduction in carbon footprint and 96% reduction in land use *versus* traditional beef burgers.[73]

Perfect Day Foods is bringing a similar approach to milk, cheese and ice cream, using genetically engineered microbes to produce animal-free dairy products.[74] Given the high carbon intensity of dairy products (nearly 12 kilograms of carbon dioxide are produced for every kilogram of butter, for example)[75] plant-based dairy has the potential to have an outsized impact.

Motif FoodWorks, a spinoff of biotech leader Ginkgo Bioworks, is employing synthetic biology to develop fermentation-based ingredients to enhance the taste and texture of plant-based meat and dairy options. Motif is expected to launch its first commercial product—an ingredient to improve the flavor of beef substitutes—in 2021.[76]

One of the more novel applications of biotechnology is cultured meat products. New Age Meats is one of several companies working to produce cultured meat, an engineered tissue produced in laboratories by microorganisms that induce and feed the growth of animal muscle cells in a bioreactor. Unlike plant-based approaches, cultured meat is a drop-in option for applications in which specific meat attributes are desired. Cultured meat production is an energy-intensive process that requires more energy than poultry production and almost as much energy as pork production (albeit less than sheep or cattle production). But cultured meat's lack of methane production and ability to utilize low-carbon energy sources is projected to reduce GHG emissions up to 96% compared to traditional meat products.[77] Cultured meat production also utilizes a small fraction of the land required by livestock production, potentially resulting in lower indirect GHG emissions from land-use change. Cultured meat's consumer acceptance is currently limited by its high production costs and novelty, although this is expected to change as the product moves toward commercialization.[78]

Feed and Feed Ingredients

Roughly half of animal agriculture emissions result from land use, production and processing of animal feed.[79] Biotechnology is being harnessed to address feed-related emissions from multiple angles, from development of new, low-carbon feed options and lower-carbon approaches to feed production to ingredients that reduce feed waste.

In addition to developing biotech options for animal products, biotech innovation is also being deployed to develop new, low-carbon animal feeds. NouriTech, a joint venture between biotech start-up Calysta and Cargill, is among a growing list of companies using microorganisms to convert methane and other heat-trapping waste gases into single-cell proteins or other ingredients for animal feed. In addition to recycling GHGs that would otherwise be emitted directly to the atmosphere, this process, known as gas fermentation, does not require the use of arable land, avoiding the largest source of GHG emissions associated with feed production. A lifecycle analysis of NouriTech's FeedKind fish feed protein found GHG emissions up to 30 percent lower than conventional fish meal, depending on the source of methane used.[80] Several biotech businesses are also developing feed ingredients using algae. Similar benefits are anticipated.

Reducing Emissions from Animals

Another leading source of GHGs from agriculture are emissions from the animals themselves. Roughly 40% of all animal agriculture emissions is attributable to methane from enteric fermentation in the digestive system of ruminant animals, for example.[81] Biotech solutions are being developed to address emissions from cattle, swine, poultry, and other animals.

Cattle are the leading source of animal emissions, due to the large numbers of cattle grown globally and their high levels of enteric methane production. Microbial feed additives have the potential to dramatically reduce enteric methane emissions from ruminant livestock by disrupting the methane production process. One ester additive suppresses the enzyme that causes methane production in the digestive tracts of cattle, reducing methane emissions by 30% or more.[82] A study in peer review of microbial feed additives developed by biotech start-up Locus Fermentation Solutions found reduction in methane levels of up to 78%.[83] And recent studies have found methane reductions of up to 99% using certain species of algae.[84–85] Feed additives based on extracts of garlic and citrus have also produced strong results.[86] All three additives are being developed for the market. Finally, two other feed additives that are already on the market, one a yeast culture[87] and the other a blend of essential oils,[88] reduce dairy cow methane emissions indirectly by increasing the efficiency of milk production, thereby reducing the number of methane-emitting dairy cows needed to produce a certain volume of milk.

Biotech enzymes from Novozymes and others have also been introduced into pig and chicken feed to improve nutrient uptake, reduce waste, and substantially reduce carbon footprint.[89]

Emissions of methane and nitrous oxide from manure is another significant source of GHGs, accounting for ten percent of emissions from animal agriculture.[90] As mentioned previously, biotechnology has a key role in reducing these emissions as well. The use of anaerobic digestion in animal agriculture has the potential to reduce U.S. GHG emissions by 151 $MTCO_2eq.$ annually by 2050 using current technology.[91] Considerable research and development is also underway to utilize biotechnology to improve the efficiency of anaerobic digestion through optimization of the microbes and microbial communities used.[92]

Open manure lagoons are capable of both reducing existing methane emissions and displacing fossil fuels when converted to enclosed anaerobic digesters. These systems capture the lagoons' methane emissions in the form of biogas that can be used to displace fossil fuels such as natural gas as a source of heat and/or electricity. The combustion of the biogas converts the methane into the less-potent GHG carbon dioxide. (One ton of methane has 84 times the global warming potential over 20 years of a ton of carbon dioxide.)[93] This capability, when combined with fossil fuel displacement, can result in carbon intensity values for biogas that are very negative despite not involving net carbon sequestration. Biogas that is produced from dairy manure and injected into natural gas pipelines for use as transportation fuel in compressed natural gas vehicles under California's LCFS has received certified carbon intensities that are almost four times lower than that of gasoline, for example.[94] One estimate calculated that up to 3% of total U.S. electricity consumption could be met by biogas produced in manure lagoons and captured for use with microturbines.[95]

Increased demand for animal protein will cause the livestock sector's contribution to global GHG emissions to increase in the years ahead. The use of biotechnology to limit the climate change impacts of livestock production is at a comparatively early stage of development due to a lack of low-carbon incentivizes, such as those that have existed in the U.S. power and transportation sectors since the turn of the century. Biotechnology has the potential to drive both near-term and long-term GHG emission reductions in the livestock sector, however. Feed additives and the use of enclosed anaerobic digesters can reduce near-term emissions.

Food and Feed Waste

Waste from food and feed production and delivery is also a significant source of GHG emissions. Nearly ⅓ of all food produced is wasted annually. This food waste had a carbon footprint of 3.3 $GtCO_2eq$ in 2007, representing seven percent of total global GHG emissions, according to the FAO.[96] Biotech solutions are available or under development to reduce food waste at multiple stages of the food and feed system.

The use of enzymes in bread and other baked goods has significantly enhanced product shelf life and reduced waste.[97] Organic acids and other products of industrial biotechnology have been developed by BASF and others to reduce spoilage of animal feeds.[98] Other biotech innovators are developing biobased antimicrobial coatings to reduce spoilage and inhibit pathogens in fruits and vegetables.[99] Others still are focusing on the use of biosensors to optimize produce ripeness to minimize spoilage.[100–101]

Food Ingredients

Biotechnology is also reducing the carbon footprint of a variety of food ingredients. The plant-based sweetener, stevia, for example has shown an 82% reduction in car-

bon footprint compared with beet sugar and a 64% reduction compared with cane sugar.[102] But the most desirable compounds of the stevia leaf are present in very low concentrations, limiting its market. Biotech leaders Evolva and DSM have developed pathways to produce those key stevia compounds through fermentation. Both have formed partnerships with Cargill and began production of fermentation-based stevia at commercial scale in 2019. Cargill's initial lifecycle assessment suggests the fermentation-based stevia has an even lower carbon footprint than the plant-based extract.[103] Nearly 200 million tons of sugar are produced globally each year.[104] With a carbon footprint of 241 kg CO_2e per ton of sugar,[105] the sugar sector accounts for roughly 48 $MTCO_2$ annually.

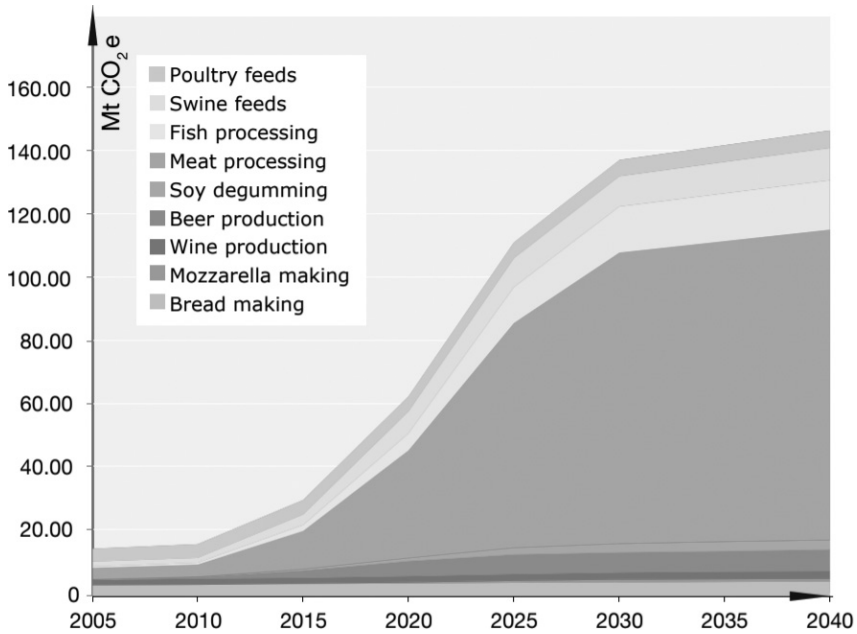
Biotechnology	Applications in Food and Feed Waste
Organic Acids	Reduce Spoilage In Animal Feeds
Biobased Coatings	Reduce Spoilage and Inhibit Pathogens in Fruits and Vegetables
Biosensors	Optimize Ripeness to Minimize Spoilage
Plant Genetic Engineering	Develop Food Varieties With Less Spoilage
Animal Genetic Engineering	Develop Farmed Animals That Require Less Food

As another example, vanillin, one of the most widely used synthetic food ingredients, was traditionally produced through a carbon- and energy-intensive process using coal tar. New biotech routes now allow for purer production without reliance on extraction or processing of fossil fuels.[106]

Food Processing

Biotech enzymes are also being used to dramatically lower the carbon footprint of food processing. The most significant example is the use of enzymes in meat processing. By eliminating energy-intensive traditional processing steps, industry-wide integration of enzymatic processes for meat processing would result in over 100 $MTCO_2e$ annually, according to the World Wildlife Fund. Smaller, but significant, reductions would result from adoption of enzymatic processing in fish and dairy processing, and beer and wine production. WWF estimated the total potential reductions from enzyme applications in the food sector at 114 to 166 $MTCO_2e$ annually.[107]

Figure 2. Potential GHG reductions from applications of biotechnology in the food industry.



Source: *Figure 5, https://wwfeu.awsassets.panda.org/downloads/wwf_biotech_technical_report.pdf.*

Veramaris Case Study

Fish are among the lowest carbon intensity sources of meat.[108] As global demand for animal products continues to grow, and with most of the world's wild fish stocks at, or beyond, sustainable harvest levels,[109] aquaculture—farmed fish and other seafood—will play a key role in mitigating the impact of meat consumption on the climate.

Salmon aquaculture is the fastest-growing food production system in the world.[110] Salmon's popularity and relatively low-carbon intensity make it an attractive option to displace some of the projected growth in the consumption of beef and other higher carbon intensity meats. The growth of salmon aquaculture is currently limited by the availability of the marine omega-3 oils EPA and DHA, key components of salmon diets. Marine omega-3 oils have, until recently, been derived almost exclusively from wild-caught oily fish, such as anchovy and menhaden, whose wild stocks are limited and increasingly threatened by climate change.[111]

Veramaris, a joint venture between biotech leaders DSM and Evonik Industries, has eliminated this supply chain and sustainability barrier by developing a biotech approach to marine omega-3 oil production. Veramaris identified marine algae that produce EPA and DHA naturally, and recently began commercial production of algae-based omega-3 oils at a $200 million facility in Blair, Nebraska.[112] The facility can produce omega-3 oils equivalent to 1.2 million tons of wild-caught fish, enough to supply 15 percent of salmon farming industry demand,[113] and has brought jobs and economic development to a region hit hard by low commodity prices and recent trade disputes.

By sourcing omega-3 oils from locally grown algae, Veramaris also dramatically shortens the feed supply chain, reducing emissions associated with the harvesting, processing, and transport of fish oil.

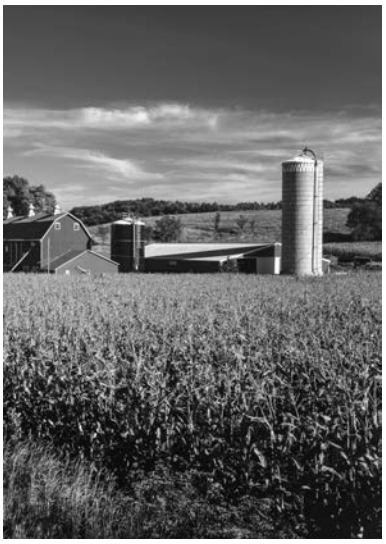
2.2 Agriculture Inputs and Climate Services

2.2.1 Agricultural Biological

Modern agriculture is an energy-intensive process. In addition to the need to fuel heavy machinery, many farming practices release carbon dioxide from both biogenic and fossil sources that would otherwise remain stably sequestered. Intensive tilling practices expose soil carbon to the atmosphere, allowing it to react with oxygen to form carbon dioxide. Nitrogen fertilizers increase the sequestration potential and minimize the land footprint of crops, but they are derived from fossil fuels such as natural gas and generate the potent GHG nitrous oxide. Advances in crop science and technology can mitigate some of these unwanted environmental effects. No-till agriculture using herbicide-resistant crops limits soil disruption and reduces the amount of soil carbon that is released to the atmosphere as carbon dioxide. The development of crop varieties with added or improved nitrogen-fixing capabilities allows for more efficient use of nitrogen fertilizer when combined with crop rotation practices.[114] And the engineering of commonly used crops to give them resistance to environmental threats such as drought and pests enhances their carbon sequestration potential while minimizing indirect GHG emissions from deforestation.

One of the fastest growing, and most promising, applications of biotechnology is in agricultural biologicals. Soil microorganisms play a key role in plant growth, enabling efficient access to nutrients and protecting against pests and diseases. Ag biologicals leverages biotechnology to improve soil microbes and enhance these natural processes. A major area of focus for ag biologicals companies is increasing plant uptake of nitrogen to allow for more efficient use of synthetic nitrogen fertilizer. Synthetic nitrogen fertilizer is a significant source of climate-warming gases. It is energy intensive to produce, and a substantial fraction of the nitrogen in fertilizer becomes nitrous oxide (N_2O) a greenhouse gas 298 times more potent than carbon dioxide. Joyn Bio, a joint venture between the synthetic biology company, Ginkgo Bioworks, and Bayer, is engineering microbes to enable cereal crops like corn, wheat, and rice to convert nitrogen from the air into a form they can use to grow, allowing for more efficient use of synthetic fertilizers for many of the world's leading crops.

Other biotech researchers and businesses are developing nitrogen- and carbon-fixing bacteria or algae to build soil carbon and enhance the absorption of atmospheric nitrogen by soils.[115–116] And biotech innovators such as Vestaron are developing safer, more sustainable crop protection tools, such as biological peptides, to provide crops with greater resiliency to plant stress induced by climate change.[117]



Joyn Bio Case Study

Nitrogen is an essential nutrient for plant growth, but the abundant nitrogen in the atmosphere is not in a form that plants can use. Soybeans, peanuts, and other legumes have developed a symbiotic relationship with nitrogen-fixing microorganisms in the soil that convert nitrogen from the air into a form they can absorb through their roots. But cereal crops like corn, wheat, and rice don't have this ability, and require the addition of fertilizers to maximize growth.

Synthetic nitrogen fertilizers have revolutionized farming, but are a potent source of agricultural greenhouse gas emissions. They are energy intensive to produce, and a substantial fraction of the nitrogen in fertilizer becomes nitrous oxide (N_2O) a greenhouse gas up to 298 times more potent than carbon dioxide.[118] Joyn Bio, a joint venture between the synthetic biology company, Ginkgo Bioworks, and Bayer, is using biotechnology to reduce agricultural GHG emissions by designing nitrogen-fixing soil microbes that work with corn and other cereal crops, allowing for more efficient use of synthetic fertilizers for many of the world's leading crops.

2.2.2 Biological Carbon Capture, Use and Storage

Biomass is one of America's major, albeit transitory, carbon sinks. All forms of biomass that employ photosynthesis capture atmospheric carbon dioxide and convert it to carbon-based compounds such as sugars, starch, and lignocellulose. The carbon content of this biomass remains sequestered until the biomass is either consumed or decomposes, at which time much of it is oxidized and released back to the atmosphere as carbon dioxide. Some of the carbon content, such as that contained in a plant's roots, is sequestered for much longer time periods in the form of below-ground biomass. It is for this reason that the afforestation/reforestation of marginal land can result in the formation of new carbon sinks and the long-term removal of carbon dioxide from the atmosphere.

Carbon that is sequestered as below-ground biomass can remain in that state so long as the surrounding soil is not disrupted. The length of time that biomass's aboveground carbon content remains sequestered depends on how the biomass is utilized. The combustion of biomass, whether in its natural form or following conversion to biofuel, results in the oxidation and release of its carbon content as carbon dioxide. While carbon-neutral in the sense that the released biogenic carbon had been captured from the atmosphere during the growing season, traditional combustion prevents the carbon from being either sequestered or reused prior to the completion of another growing season.

A variety of biotechnologies have been developed that either capture and sequester or recycle atmospheric carbon dioxide. Many of these processes are closely related to the biobased products covered in Section 2.1 because of the ability of biomass to capture atmospheric carbon dioxide before being converted to different fuels

and products. The technologies in question impact every stage of the biomass supply chain, from growth/production to conversion and ultimately end-of-life disposal.

Carbon capture and storage (CCS) technologies enable carbon dioxide emissions from fossil power plants or industrial facilities, such as cement or steel, to be captured at the facility and stored underground. A variety of approaches have been developed to absorb carbon dioxide from flue gases, or to remove carbon prior to combustion.[119] CCS can also be deployed at facilities utilizing biomass as feedstock. The process is largely the same as that employed at some fossil fuel facilities but, whereas fossil energy carbon capture and sequestration (FECCS) processes reduce the GHG emissions of fossil fuels, biomass energy carbon capture and sequestration (BECCS) processes actually reverse past emissions. The biomass captures atmospheric carbon dioxide during its growth phase and is then combusted, yielding both energy and carbon dioxide. The bioenergy displaces fossil energy and the carbon dioxide is either sequestered in underground caverns as a gas or converted to a degradation-resistant solid such as biochar. BECCS is therefore a carbon-negative process in that it results in more carbon dioxide being sequestered than emitted. Biotechnology advances that increase the growth rate, growth potential, and harvest efficiency of biomass that is used as BECCS feedstock all enhance the process's carbon sequestration capability.

BECCS technology can also be deployed to achieve negative carbon results at any industrial facility using biomass as a feedstock. Perhaps the most intriguing application of BECCS is its potential use at ethanol plants and other biorefineries. One third of the carbon in the biomass feedstock used to produce ethanol is released in the form of carbon dioxide during the fermentation process. Using BECCS to capture this CO_2 reduces the carbon intensity of ethanol by 40%.[120] Biorefineries represent an extremely attractive option for deploying BECCS because the product of fermentation is a nearly pure (99%) stream of CO_2, requiring little or no separation from other gases. As a result, biorefinery BECCS is among the lowest-cost carbon capture opportunities available, at an estimated cost of under $30 per ton of CO_2 compared to $60–$120 per ton at fossil power plants or traditional industrial facilities.[121] The world's first ethanol BECCS project is now in operation in Decatur, Illinois, capturing and storing 1 $MTCO_2eq$ per year that would otherwise have been emitted to the atmosphere.[122]

In addition to its role in providing biomass feedstocks for BECCS, biotechnology is increasingly seen as a key enabling technology for carbon capture itself. The U.S. Department of Energy (DOE) has invested over $150 million since 2015 in the development of algae and other microbial systems for carbon capture as an alternative—or complimentary—approach to chemistry-based approaches to CO_2 extraction from flue gases.[123] Microbial systems have several significant advantage over thermochemical approaches to carbon capture. Typical thermochemical CCS systems are highly energy intensive. Roughly 30% of captured carbon is offset by the additional fossil fuel combustion required to separate, compress, and transport the captured carbon.[124] Microbial systems can dramatically reduce this "parasitic load." Algae and other microbes extract CO_2 or other target gases biologically, via photosynthesis or other natural energy pathways, eliminating the energy inputs required for separation. Microbial systems can even operate efficiently at the relatively low CO_2 concentrations found in flue gases from natural gas or coal-fired power plants, and can be deployed economically at relatively small scale to address emissions from smaller power plants and industrial facilities that cannot support traditional CCS systems. Microbial systems also convert the captured carbon into a usable solid or liquid form directly, eliminating the substantial energy inputs required to compress captured CO_2 for transport, or for use in enhanced oil recovery. As such, *microbial carbon capture systems applied to biomass energy or other biorefinery systems offer one of the most carbon-negative climate solutions available.*

DOE in its 2016 Billion Ton Report found that *suitable land and other infrastructure exists to deploy algae-based carbon capture systems at more than 500 power plants and ethanol facilities in the U.S. These systems would have a potential to capture more than 200 MT CO_2 annually.*[125]

Biomass and carbon capture can then be combined with the carbon dioxide recycling technologies discussed in Section 2.1 to produce negative-carbon products from captured biogenic carbon. The biomass energy carbon capture and utilization (BECCU) process displaces both fossil energy consumption and fossil fuel emissions. As with BECCS, BECCU uses biogenic carbon to generate energy via combustion, displacing fossil fuels in the process. The resulting carbon dioxide is captured but, instead of being sequestered, is converted into yet another fuel or product that displaces additional fossil fuels. BECCU can still be carbon-negative, either because it displaces more carbon dioxide emissions from fossil fuels than it emits when the utilization takes the form of conversion to biofuels or biodegradable products, or be-

cause the utilization takes the form of conversion to non-biodegradable products.[126] In the latter case, carbon sequestration still occurs, but in a long-lifetime product, rather than geologic storage.

BECCS and BECCU are not widely employed in the U.S. at present due to a relative lack of economic or policy incentives for the capture of carbon dioxide. Those CCS projects that do exist in North America involve fossil rather than biogenic sources of carbon.[127] That said, climate scientists increasingly believe that the two technologies will need to be widely utilized if catastrophic climate change is to be avoided. The UN's Intergovernmental Panel on Climate Change (IPCC) has concluded that keeping the atmospheric carbon dioxide level below 450 ppm by 2100, as is necessary if catastrophic climate change is to be avoided, will require the "availability and widespread deployment of BECCS and afforestation."[128] The primary hurdle facing BECCS/BECCU commercialization is one of economics rather than technology: carbon capture is economically unattractive at a time when the cost of emissions is lower than the cost of capture.[129] The technical feasibility of capture and sequestration is especially well-established for those technologies that rely upon natural processes such as the building of soil carbon via afforestation/reforestation or the planting of certain dedicated energy crops. BECCU also offers an advantage over BECCS in the absence of a high emissions cost due to its production of higher-value products such as fuels or chemicals; BECCS, by contrast, produces lower-value products such as heat and electricity.[130]

The ability of BECCS to achieve net-negative carbon emissions and their magnitude depend on several different factors involving the different stages of the supply chain. A comparison of multiple biomass feedstocks combusted in a power plant equipped with CCS technology determined that while growth of the three feedstocks considered (Miscanthus, switchgrass, and willow) all have the potential to achieve net sequestration, the actual amount of sequestration that occurs is determined by biomass transportation distances, carbon capture rates, and especially land-use change (*e.g.,* what type of land that the biomass feedstock is grown on).[131] The analysis calculated that the amount of carbon dioxide ultimately sequestered on average while generating 1 megawatt hour of electricity via BECCS with Miscanthus and switchgrass is equal to the average amount emitted by U.S. power plants to generate an equal amount of electricity.

BECCU has also been found to achieve low-to-negative carbon intensities. A life cycle assessment that compared the carbon intensities of ethanol produced from steel mill waste gases found its carbon footprint to be at least 60% lower than that of gasoline.[132] Dedicated energy crops such as Miscanthus and willow grown for the purpose of electricity generation have been found to achieve net-negative emissions of carbon dioxide due to the combined effects of soil carbon sequestration and the displacement of fossil fuels.[133] A different analysis found emissions via afforestation/reforestation to also be negative even if the forest is harvested and utilized as wood products such as sawtimber, as these constitute a different form of BECCU.[134]

The carbon dioxide reduction and sequestration potential of BECCS/BECCU technologies is very sensitive to land-use change. For example, the largest amount of sequestration occurs when dedicated energy crop growth or afforestation/reforestation occurs on abandoned or marginal croplands that have previously had their soil carbon depleted. On the other hand, the conversion of grassland to these uses results in a reduced sequestration potential, while the conversion of productive cropland can have the lowest sequestration potential of all if the resulting decrease in the supply of the crop causes the conversion of land such as forest to cropland somewhere else. Biotechnology provides several methods for mitigating these unintended consequences through advances in plant and crop science that are described in more detail in Section 2.4.1.

LanzaTech Case Study

LanzaTech is unique for its ability to make low-carbon fuels and chemicals from a variety of waste-based feedstocks, including industrial emissions, unsorted, unrecyclable municipal solid waste, and agricultural or forestry wastes and residues. The company utilizes a naturally occurring bacteria originally isolated from rabbit droppings. As part of its natural biology, the bacteria ferments gases containing carbon dioxide, carbon monoxide, and/or hydrogen into ethanol. This ethanol can be used directly as a fuel to displace gasoline or as a chemical in consumer products.[135] Additionally, ethanol can be upgraded to make consumer goods from polyethylene[136] or PET, and to make sustainable aviation fuel (SAF) via the LanzaJet Alcohol-to-Jet pathway,[i] to displace fossil fuel demand in the aviation sector. The opportunities for LanzaTech's technologies to utilize waste carbon to produce multiple low-carbon fuels and chemicals has expanded over the last decade as its technology has been licensed worldwide.

The LanzaTech pathway differs from conventional ethanol production in that it feeds its microorganisms with a gas stream rather than a liquid sugar substrate. While carbon is the most important ingredient in this gas stream, the microorganisms are capable of fermenting gases produced from a variety of industrial processes and feedstocks. The gases are captured and compressed before being delivered to a bioreactor where fermentation to ethanol occurs. The ethanol is then recovered from the bioreactor and stored for future use either in that form or following subsequent upgrading to a hydrocarbon fuel.

The first commercial-scale facility to utilize LanzaTech's pathway is a steel mill located near Beijing, China. Waste gases produced at the mill are captured and fermented to ethanol at a rate of 16 million gallons per year. The company estimates that the recycling of the mill's GHG emissions in this manner is the equivalent of removing 80,000 cars from the road annually.[ii] The success of the technology at such a large scale has resulted in plans to apply it to other types of industrial facilities, including a petroleum refinery in India that will achieve an annual ethanol yield of 11 million gallons, a steel mill in Belgium that will achieve an annual ethanol yield of 21 million gallons, and a smelter in South Africa that will achieve an annual ethanol yield of 17 million gallons.

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[i] *http://www.lanzatech.com/2019/11/22/lanzatech-moves-forward-on-sustainable-aviation-scale-up-in-the-usa-and-japan/*.

Editor's note: there appears to be a discrepancy in the numbering of the footnotes. Footnotes 137–139 were used in the *LanzaTech Case Study* and were duplicated in the following section. To avoid confusion the *LanzaTech Case Study* footnotes are renumbered [i]–[iii].

[ii] *http://www.cnbc.com/2018/07/27/lanzatech-turns-carbon-waste-into-ethanol-to-one-day-power-planes-cars.html*.

Beyond recycled carbon fuels, LanzaTech's platform can make second generation biofuels through gasification of biomass wastes and residues. LanzaTech is developing a project to convert locally available agricultural residues to approximately 5.3 million gallons per year of fuel grade ethanol in India, using commercially proven gasification technology and LanzaTech's commercially proven gas fermentation platform. The integrated technology will have the flexibility to process a wide range of biomass feedstocks enabling rapid replication at other locations.

A by-product of the project will be a nutrient rich biochar. Biochar can be a useful soil supplement to enrich soil organic carbon and other nutrients. In 2018, LanzaTech launched a new company, LanzaJet to accelerate the commercialization of SAF production. The LanzaJet process can use any source of sustainable ethanol for jet fuel production, including, but not limited to, ethanol made from recycled pollution, the core application of LanzaTech's carbon recycling platform.

Commercialization of this process, called Alcohol-to-Jet (AtJ) has been years in the making, starting with the partnership between LanzaTech and the U.S. Energy Department's Pacific Northwest National Laboratory (PNNL). PNNL developed a unique catalytic process to upgrade ethanol to alcohol-to-jet synthetic paraffinic kerosene (ATJ–SPK) which LanzaTech took from the laboratory to pilot scale. SAF produced via the company's pathway has already been employed in two commercial flights to demonstrate its ability to displace fossil aviation fuel.[iii] LanzaTech estimates that SAF produced using its technology achieves a 70% reduction to carbon intensity compared to fossil aviation fuel.

2.3 New Biotech Tools and Bioindustrial Manufacturing

2.3.1 New Biotech Tools

Rapid advances in the fundamental tools of biotechnology increasingly are enabling biotech solutions in manufacturing sectors beyond food, fuels and chemicals. These developments offer the potential for transformative climate solutions in applications beyond manufacturing as well.

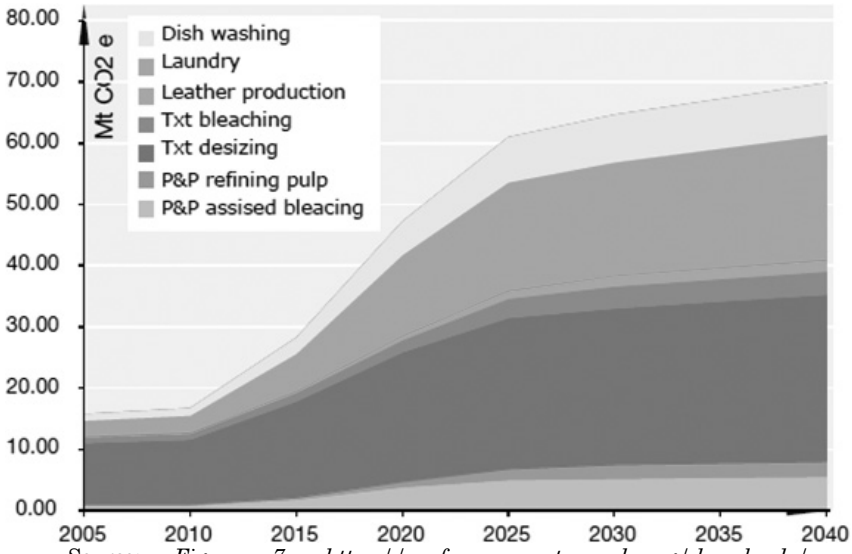
Biotech tools for manipulating DNA have been in use for decades. Many of the most important contributions of biotechnology—vaccines and therapies, biotech crops, and modern industrial biotechnology—were made possible by this first generation of genetic engineering tools. But the past decade has seen a wave of new biotech tool innovation with transformative potential. In synthetic biology, scientists insert synthesized pieces of DNA into an organism's genome to alter the characteristics or function of the organism. In genome editing, scientists use tools to make more precise changes to the organism's own DNA to achieve the same outcome.[137] These and other new biotech tools have dramatically increased the speed and reduced the cost of genetic engineering applications and are being deployed to tackle a range of global challenges, including climate change.[138]

2.3.2 Applications of Bio-Manufacturing in Traditional Industries

Some of industrial biotechnology's earliest uses were in the application of enzymes to improve efficiency and reduce energy use in traditional industries. The introduction of enzymes for pulp and paper bleaching, for example, reduced energy consumption 40% *versus* traditional bleaching, and a shift to fermentation-based production of riboflavin (vitamin B_2) in the early 2000's reduced associated CO_2 emissions 80% compared to the traditional chemical manufacturing route.[139] Applications of enzymes in textile processing, such as pretreatment, bleaching and desizing, save approximately 10 $MTCO_2e$ annually today. Full adoption of these technologies would triple these reductions. The widespread use of enzymes in laundry and dishwasher detergent could save an additional 30 $MTCO_2e$ annually by 2040 by allowing for cold-water washing of laundry and more efficient dishwashing. Full market penetration of biotech applications in these traditional industries is estimated to save 65 $MTCO_2e$ annually by 2030.[140] While these GHG are incremental relative to the global challenge of climate change, they represent near-term opportunities that will be essential to reducing near-term emissions.

[iii] *http://www.lanzatech.com/2018/10/04/virgin-atlantic-lanzatech-celebrate-revolutionary-sustainable-fuel-project-takes-flight/*.

GHG reduction potential from applications of biotechnology to traditional industries.



Source: *Figure 7, https://wwfeu.awsassets.panda.org/downloads/wwf_biotech_technical_report.pdf.*

2.3.3 New Markets and Novel Applications

With the emergence of synthetic biology and the ability to tailor microbes to specific industrial tasks, industrial biotechnology solutions are moving into an ever-expanding range of applications. A rapidly growing number of companies, such as Gingko Bioworks, Arzeda, and Twist Biosciences, are providing organism design and DNA synthesis services, using synthetic-biology and other modern biotechnology tools to optimize manufacturing pathways. SynBio companies raised over $1 billion in investment in the second quarter of 2019 alone.[141] One intriguing potential application of these new biotech tools is in biological data storage, the storage of data on strands of DNA instead of semiconductors or magnetic devices. DNA is roughly a million times denser than conventional hard-disk storage. Testing is now underway with computers that store data by synthesizing strands of DNA. A shift to biological data storage would eliminate the need for mining and production of silicon or precious metals. More significantly, it could dramatically reduce the need for massive data storage facilities.[142] Energy consumption by data storage facilities already accounts for 2% of global GHG emissions, and is projected to surge to 14% of global emissions by 2040.[143] DARPA, the Defense Department's Advanced Research Projects Agency, is investing $15 million in work by Microsoft, Twist Bioscience, and others to develop DNA storage.[144] A collaboration between the University of Washington and Microsoft successfully demonstrated their fully-automated end-to-end DNA storage process in 2019.[145]

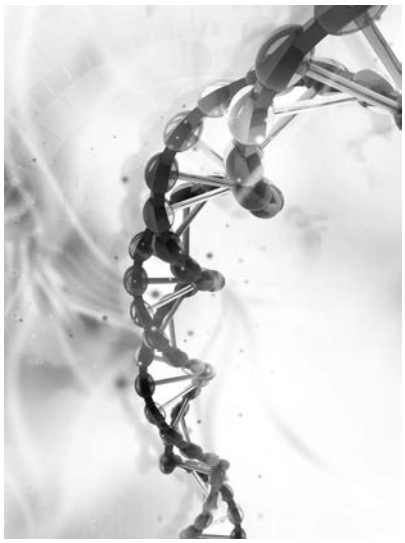
Biology-based parallel computing—in which biomolecules are used to test a large number of solutions to a problem simultaneously—is also being evaluated as another potential application of biotechnology. A proof of concept experiment at McGill University yielded a solution to a complex mathematical problem with less than 0.1% of the energy required to solve the problem with traditional computing.[146]

Synthetic biology is also being deployed to accelerate the development of solutions to the COVID–19 pandemic.

In addition to applications in manufacturing, synthetic biology has the potential to provide transformative solutions for carbon dioxide removal from the atmosphere and oceans.[147]

Synthetic biology could be applied to enhance photosynthetic efficiency of trees, or reduce respiration from soil microbes, to shift natural carbon cycles towards carbon removal. Even small improvements in these natural carbon cycles could have profound impacts, given that 120 $GTCO_2e$ is removed from the atmosphere by terrestrial photosynthesis.[148] As discussed in section 2.2.2, deployment of microbial

systems for carbon capture has the potential to further draw down atmospheric carbon concentrations.*



Inscripta Case Study

The power of synthetic biology lies in its ability to make possible microbes to perform any task. SynBio innovators are applying the tools of their trade to design microbes to make plastics from plants, optimize fertilizer, capture carbon and even combat COVID–19. But unlocking the full potential of synthetic biology to take on the world's greatest challenges—including climate change—will require synbio tools to be available to every scientist or biotech start-up.

Jennifer Doudna at the University of California, Berkeley, and Emmanuelle Charpentier at the Max Planck Institute in Berlin were awarded the 2020 Nobel Prize in Chemistry for their work in developing the CRISPR gene editing technique, an approach that has revolutionized genetic engineering. But, until recently, CRISPR technology was prohibitively complex and expensive for most researchers.

In 2019, Boulder, Colorado-based Inscripta flipped the script, launching an affordable system that can perform thousands of gene edits at the push of a button.[150] This innovation has attracted hundreds of millions of dollars in venture capital investments and a growing list of global customers, many of whom will surely apply the technology to addressing global climate change.

2.4 Plant and Animal Biotechnology

2.4.1 Plant Biotechnology and Gene Editing

Biomass has a critical role to play in efforts to mitigate climate change. As described in Sections 2.1 and 2.2, biomass can replace a wide variety of fossil fuels and products, reducing or even sequestering carbon dioxide emissions in the process. At the same time, though, biomass can contribute to climate change if it is used unsustainably, and it will need to adapt to unprecedented growing conditions as the planet continues to warm. Biotechnology is providing important advantages on both counts, enhancing the amount of biomass that can be sustainably harvested while also improving the climate resiliency of many important crops and other plants.

Genetically modified organisms (GMO) have been used since the 1990s to make important crops such as grains and oilseeds resistant to common threats including drought and pests. These past breakthroughs mitigated climate change by reducing the amount of land required by the agriculture sector. Yields of corn per acre in the U.S. increased by approximately 60% between 1991 and 2019[151] while those of soybeans increased by almost 50% over the same period.[152] There were fewer acres of cropland in production in the U.S. in 2012 than there were in 1945,[153] despite the

*__Editor's note:__ there is no corresponding footnote reference for footnote 149. The reference as been incorporated herein as follows:

large increases to the U.S. and world populations that occurred over that time, due to this improved productivity.

It is important that these productivity increases continue to be made in the coming decades if agriculture's contributions to climate change are to be limited. The continued growth of the global population will create additional demand for crops at a time when growing seasons and conditions are expected to become more uncertain due to climate change.[154] Future food crop shortages, whether due to increased demand from population growth or crop failures caused by extreme weather, would potentially contribute to climate change by encouraging the conversion of carbon sinks such as grassland and forests to cropland, thereby releasing carbon dioxide sequestered in the biomass and soil to the atmosphere. Likewise, improvements to the resiliency of dedicated energy crops during extreme weather events will improve both climate and energy security by enabling their utilization as low-carbon bioenergy and bioproduct feedstocks to increase.

Biotechnology is also enabling the expansion of existing bioenergy pathways. The U.S. is currently undergoing a rapid increase to its renewable diesel production capacity that will result in additional demand for lipid feedstocks.[155] Work is underway to utilize fast-growing and/or resilient undomesticated biomass such as *Jatropha* and microalgae as biofuels feedstocks. Both forms of biomass can grow on marginal lands while limiting the disturbance of existing carbon sinks. However, their utilization as bioenergy has historically been constrained by poor crop yields outside of the laboratory. Cell engineering has enabled the necessary yields for commercial production to be achieved in microalgae,[156] and research is actively underway to improve *Jatropha* as a feedstock.[157] Biotechnology is also being utilized to expand the supply of lipid feedstocks by enabling the conversion of waste products, as is described in Section 1.1.1.

The development of the CRISPR gene editing technique over the last decade has already led to notable breakthroughs in the effort to mitigate climate change. In addition to microalgae,[158] multiple strains of bacteria, yeast, and filamentous fungi have been modified via the CRISPR technique to increase the yields and types of products produced via fermentation.[159] The CRISPR technique has also been employed with dedicated energy crops such as Miscanthus, poplar, switchgrass, and willow to refine specific traits that improve both resiliency and yields, although the higher complexity of these forms of biomass and regulatory uncertainty about their possible status as genetically modified organisms have slowed progress.[160] Finally, CRISPR gene editing has also been employed to improve the resiliency and carbon efficiency of first-generation bioenergy feedstocks such as corn[161] and soybeans under the types of extreme weather conditions that are expected to occur with growing frequency as a result of climate change.[162]

Biotechnology is also being used to develop plant varieties, including apples and potatoes, that extend shelf life and avoid cosmetic issues, such as browning or spotting, that cause consumers to throw away food.[163]

Biotechnology has enabled major improvements to the yields, land-use efficiency, and resiliency of important U.S. bioenergy feedstocks in recent decades. Continued biotechnology advances will need to occur in the near future if these improvements are to be maintained, let alone expanded upon. Climate change is expected to result in extreme weather events that are greater in frequency, magnitude, and duration, and these will threaten production of both the feedstocks that have contributed heavily to U.S. bioenergy and bioproducts to date as well as the plant biomass that slows the rate of atmospheric GHG concentration increase. The development of the CRISPR gene editing technique, along with continued advances in more traditional genetic engineering processes, will do much to enhance the ability of biomass to mitigate fossil fuel consumption and GHG emissions.

2.4.2 Animal Biotechnology

In addition to the on-farm applications addressed in previous sections, biotechnology is also being leveraged to improve the carbon efficiency of animal agriculture through genetic engineering of the animals themselves. The biotech AquaBounty salmon, for example, requires 25% less feed than traditional Atlantic salmon. The combination of lower inputs and a closed-loop, land-based production system that can be deployed much closer to U.S. customers is estimated to result in a carbon footprint that is 96% lower than traditional farmed salmon.[164]

Biotech tools are also being used to improve fertility, increase production efficiency, and reduce disease in cattle, swine and other animals, further reducing waste in animal production. Scientists in the U.S. are employing genomic tools to improve the ability of cattle to tolerate higher temperatures while maintaining their growth.[165] Heat stress, which is an increasing problem in the livestock sector due to climate change, limits the production of animal protein, and heat-tolerant cattle

will be better able to maintain their production efficiency as temperatures increase. The genetic sequencing of dairy cattle has likewise led to efforts to improve the efficiency of milk production via genetic engineering.[166] Livestock are a major source of the potent greenhouse gas methane, causing improvements to the efficiency of protein and milk production to have an outsized impact on GHG emissions.

3 Climate Impact Analysis

3.1 Issues in LCA for Biotechnology

Successfully mitigating the impacts of climate change will involve simultaneous transformational shifts across technology, policy and business. Effectively planning, managing and evaluating these shifts will require an equally profound shift in how we track and account for carbon. Life Cycle Analysis (LCA) is widely regarded as the most appropriate and effective way of evaluating the carbon impacts of products and processes in the complex, modern economy. LCA is an analytical technique in which all inputs, outputs and impacts of a product or process are tracked and accounted for through its full life cycle. This includes the materials used to make things, the energy and associated emissions from transporting and processing them, and what happens at the end of a product's useful life. LCA is especially important and complex when biological systems are involved, since they introduce a significant degree of uncertainty; external conditions, pathogens, or changes in surrounding ecosystems can all impact the productivity of any organism.

There are three main approaches to LCA: attributional LCA, consequential LCA and economic input-output (EIO) LCA. Attributional LCA focuses on the direct actions taken by a producer in order to make a product; all of the energy or materials consumed during production would be captured by an attributional LCA, for example. Consequential LCA, in contrast, focuses on comparing the world with the product in question to a hypothetical world without it; it not only captures all the materials used in production, but also how the product and its supply chains affect markets or other products. EIO LCA uses the flow of money through systems to estimate environmental impacts. For example, an EIO–LCA may use the average carbon emissions per dollar of revenue in the petrochemical industry to estimate the impacts of petrochemical inputs to other products. The accuracy of EIO LCA suffers because its impact-per-dollar estimates are, by necessity, industry averages or abstract estimates. It is best used for high level, market-wide estimates rather than evaluating individual products or services. Attributional LCA is simpler than consequential, especially for most manufacturing processes, but consequential LCA is widely viewed as a more accurate technique because it can account for indirect effects, such as those that occur because of changes in commodity prices or disrupted supply chains. Attributional LCA would overlook the impact of new strains of crop on agricultural markets, for example, whereas consequential approaches may be able to account for these.

The science of LCA has rapidly evolved over recent decades; however, a number of critical challenges remain pertaining to LCA in biotech:

Lack of Data on Critical Inputs or Processes—Like most modeling techniques, the results of an LCA are only as good as the input data. In many cases, critical elements needed to understand the impacts of a product or process are unavailable, due to insufficient fundamental research, protections on proprietary information, or changes in technology. One common example is that many biotechnological manufacturing systems use enzymes or catalysts. Data on the energy or materials used to make these inputs is typically considered proprietary business information, which renders many LCAs on biotech products uncertain, at best. In other instances, the only source of data on an industrial practice is extrapolated from textbooks or older research on the subject, often overlooking recent technological developments in the field.

Inadequate tracking of existing markets or systems—Consequential LCA's value derives largely from its ability to assess indirect effects. A common example of an indirect effect is Indirect Land Use Change (ILUC), which occurs when a system uses an agricultural product as its input, such as a biofuel made from soybean oil. While the biofuel itself may release little carbon during its production or use, the gallons of soybean oil which went into the biofuel would have otherwise been consumed elsewhere, such as in food products, animal feed or cosmetics. Those previous consumers must now find alternative sources of vegetable oil on the open market, driving up prices, which may result in clearing land to grow more oilseed crops. This land clearance is ILUC, the acres being cleared may not be used to produce biofuel, but they are cleared because of biofuel. Consequential LCA often requires tracking markets, land use, or behavior over a long period of time in order to establish "normal" behavior in that system; at present these data are often not collected, or are proprietary.

Multiple LCA Methods—LCA is at its heart a scientific exercise, but parts of it require subjective judgment, like decisions about how to define system boundaries or allocate impacts between multiple products. There may be multiple valid answers to these judgment questions. For example, in the U.S. almost all ethanol production takes in corn and produces ethanol as well as the solids left behind after processing, which are typically sold as a high-protein animal feed known as "distiller's grains". The question for LCA practitioners is how much of the energy used in the process is assigned to the ethanol product *vs.* the distiller's grains. There are several methods for doing this, such as assigning based on the relative mass, energy content or monetary value of each product, but there is no objectively right or wrong answer about which method should be selected; it's a judgment call. When true objectivity may be impossible to attain, consensus can be a reasonable substitute. Government, industry and academic stakeholders can mutually agree on answers to questions like this to ensure that at the very least, LCAs can be made on the basis of similar assumptions, so that they can be effectively compared against each other.

Ultimately, the analytical tools which support LCA will need to evolve in parallel with the biotech industry as it rises to meet the challenge of climate change. Industry groups can help support the continued development of LCA data by supporting basic research, agreeing to make more data on inputs and outputs from manufacturing available to researchers, and continuing to support and publish LCA studies of their products. Luckily, LCA shares a common characteristic of many sciences: as knowledge accumulates, future studies become easier and more powerful. Groups of companies that use similar processes to make a common product can aggregate their data together to publish industry averages for energy or materials use, thereby protecting their proprietary business information while improving analysts' ability to research. LCA data developed for one study is often used in subsequent ones; students who study real-world examples emerge better prepared to contribute in real-world work; and as more studies are published and critiqued, consensus emerges. While successfully mitigating climate change will require significant new investments in cleaner technologies and production systems, complementary investments must occur in evaluation and analysis of these systems to ensure that the LCA tools necessary to inform the next decades' decisions evolve as well.

Keys to Maximizing Biotech's Potential to Reduce GHG Emissions

- GHG accounting needs to be based on life cycle analysis, and include indirect effects such as ILUC. Industry groups can help by making data available to regulators and researchers; IP can be protected by aggregating or anonymizing the data.
- Most biotech solutions will require massive amounts of feedstock, finding ways to produce this more efficiently will always be useful.
- Using waste biomass to produce energy can make a real difference, but keeping organic carbon in solid form as long as possible maximizes GHG benefits.
- Biofuels may not be zero-carbon, but they can be very low-carbon and the scale of transportation means making them sustainable and scalable is critically important.
- Carbon capture and sequestration will be necessary for success, but as a complement to reducing emissions, not a replacement.

3.2 GHG Mitigation Potential on National (U.S.) Scale

3.2.1 Producing Sustainable Biomass Feedstock

Biomass is one key to de-carbonizing the U.S. economy because it leverages the capacity of photosynthesis to remove carbon from the atmosphere and convert it to carbohydrates, which can be utilized for their embodied energy, carbon, or both. In theory, biomass can be a carbon-neutral resource, but in practice the situation is much more complex. Growing biomass, especially at commercial scales, typically requires fertilizer and other inputs which have associated emissions. Depending on how the land being used for biomass is treated, there may be additional sources, or sinks, of carbon in the soil. Understanding the emissions impacts of biomass across its full life cycle requires understanding the ecosystems, carbon and nutrient cycles at play where it's grown. Given the potential for biomass production to result in significant and unexpected emissions of carbon, a risk-averse approach is prudent, but the immense potential of biofuels, bioenergy and bioproducts argues in favor of utilizing these resources where available. While there is significant uncertainty around the emissions associated with any source of biomass, there are a few useful rules of thumb:

1. **Biomass can be low-carbon but is almost never zero-carbon.** While the carbon embodied in plant matter was taken from the atmosphere, and therefore has a minimal on climate change, there are numerous sources of climate-forcing emissions from fertilizer, irrigation, transport, processing and changes in the soil.
2. **Biobased products can reduce GHG emissions when substituted for high-carbon ones, especially those relying on fossil fuels.** GHG reductions are realized when low-carbon biobased products displace higher-carbon ones. Without that displacement, there is minimal environmental benefit. Substitution, by itself, is no guarantee of benefit, a few biobased products are more carbon-intensive than their fossil equivalents.
3. **Alternative uses and indirect effects must be considered.** Accurately assessing biomass carbon emissions typically requires considering indirect effects like ILUC, as well as what would have happened in absence of the biomass production. A cultivation system may increase soil carbon, but should only be credited for these increases if this increase is greater than what would have happened otherwise.
4. **The labels "waste" and "residue" can be misleading.** In theory, wastes or residues have no value, and cause emissions from their use. In truth, many of these materials are used in some fashion, sometimes by sustainable bioproduct systems, sometimes more traditionally, as animal bedding or returned to the soil; these uses must be considered.

Climate policy has largely overlooked emissions from agriculture to date, in part because of the complexity of the system and concern about financial impacts on farmers and rural communities. With new focus on sustainable and regenerative agriculture, however, a window of opportunity is opening to achieve a win-win scenario for agricultural producers: utilize the latest science to find opportunities to use agriculture as a tool to reduce emissions, and reward farmers for the carbon benefits they provide.

Agriculture in the U.S. emitted GHGs equivalent to about 658.6 million metric tons of carbon dioxide in 2018, roughly 10% of the U.S. total.[170]* About 94% of this was emitted from agricultural soils or livestock (direct or "enteric" emissions from animals as well as manure management). Additional emissions come from the production of ammonia, which is a primary input for most fertilizers. With continued population growth as well as the emergence of the bioeconomy, the agricultural sector will be called upon to produce even more food, fodder, fiber and feedstock. Meeting this challenge while reducing emissions will require the rapid deployment of advanced biotechnology in several critical areas including:

Optimizing fertilizer use through new crop strains or increased nitrogen fixation.

Nitrogen is often a limiting factor in agricultural yields. The "Green Revolution," which massively increased agricultural production and allowed rapid population growth during the 20th Century, was largely facilitated by the development of the Haber Process for producing ammonia from natural gas. Ammonia production supports 50–75% of global fertilizer production and is responsible for more than 1% of global GHG emissions.[171] Removing biomass from fields, whether it's crops for consumption or residues for bioenergy, takes some of that nitrogen along with it, which must be replaced. Biotech can improve plants' efficiency at utilizing nitrogen, or adding genes from nitrogen-fixing organisms to allow them to produce their own. Using modern biotechnological tools to optimize the use of synthetic fertilizers allows growers to consume less of them, which could help U.S. farmers cut back on 15–20 million metric tons of carbon associated with its production, about as much as fueling 3–4 million cars for a year.[172]

Reducing nitrous oxide emissions from soil

Nitrogen fertilizers enhance plant growth, but many soil microbes convert fertilizer nitrogen to nitrous oxide (N_2O), a greenhouse gas up to 298 times more potent than carbon dioxide. In 2017, nitrous oxide emissions from agricultural soil accounted for 266 million metric tons of carbon dioxide equivalent in the U.S. Relatively low-tech interventions, such as using less volatile fertilizers and applying them more efficiently could reduce nitrous oxide emissions by 30–100 million metric tons annually.[173] Analyses of chemical inhibitors indicate a potential to cut nitrous

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*__Editor's note:__ there are no corresponding footnote references, or footnotes for nos. 167–169. The report has been reproduced herein as submitted.

oxide emissions by over 40%, and there are promising lines of research which would integrate production of these inhibitors into a plant's root system.[174] By combining all of these approaches, nitrous oxide emissions could be reduced, by well over 150 million metric tons of carbon equivalent, or as much as shutting down 32 U.S. coal power plants for a year.

Enhancing soil carbon retention through expanded root growth

Despite its mundane appearance, soil is a complex and dynamic environment, in which carbon and nutrients enter and leave through multiple avenues and cycle through plants, animals, microbes and fungi. There are several promising approaches by which the soil carbon system could be encouraged to retain more carbon in solid form, rather than being decomposed and released to the atmosphere. Root growth is a major pathway for soil carbon accumulation, as plants take carbon from the atmosphere and convert it to solid plant matter, moving it underground as roots grow. Engineering crops to have larger and deeper root systems expands this pathway and could sequester carbon by 200 to 600 million metric tons per year if widely deployed, though this number is highly uncertain due to the relative immaturity of this technology.[175]

Reducing methane emissions from livestock

As population and incomes increase globally, so does the consumption of meat and dairy products. This leads to an increase in livestock numbers and the associated emissions. Livestock, especially cattle, are a major source of methane, from enteric sources (*i.e.,* burps) as well as from decomposing manure. Several novel feed additives have been proposed which may be able to reduce the amount of methane emitted without negatively affecting animal health or reducing yields. DSM has announced a cattle feed supplement that claims to reduce methane emissions by 30%,[176] while other compounds under investigation—often derived from red seaweed—may be able to provide 80% reductions or greater in methane emissions.[177–178] While numerous technological and policy hurdles remain, widespread deployment of feed technologies like these could reduce emissions from livestock production by 50–140 million metric tons, or roughly one to three times the annual emissions from the state of Oregon.

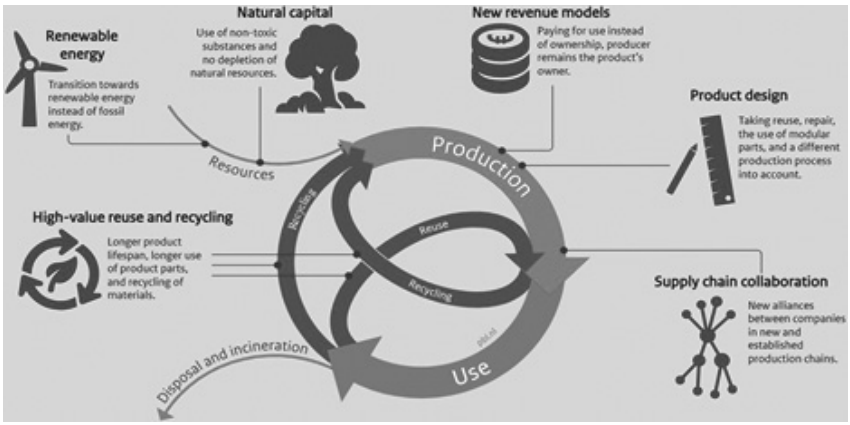
3.2.2 Empowering Sustainable Production

Empowering Sustainable Production

Modern economies produce a staggering amount of things. From millions of printed silicon microcircuits in electronics to billions of tons of concrete and steel, production of physical objects is a hallmark of human society. As we seek to limit the damage caused by climate change, a new focus on sustainability must enter the conversation about how we make things. Luckily, advances in technology have presented a number of opportunities to do just this, by developing more efficient and lower-emission alternatives to traditional industrial techniques. Biotechnology can continue this process by leveraging the affinity biological processes have for working within a circular economy.

Green is the New Black

Elements of a circular economy.



Source: PBL Netherlands.[179]

Traditionally, once materials were extracted, their life was a one-way trip that ended in a landfill. As industries become more aware of the need to reduce emissions, it is becoming clear that reuse and recycling of materials and energy is an essential tool for sustainability. Biotechnology is well-positioned to succeed in a sustainable circular economy because it is built on a foundation of biological carbon cycling. Working with natural systems which have evolved to capture and re-use carbon and nutrients, biotechnology firms can expand these processes to commercial scale, replacing energy- and emission-intensive extractive industries with low-impact circular ones.

Turning Carbon into Products

U.S. industry emits over 800 million metric tons of carbon per year from the combustion of fossil fuels; at present almost all of this goes into the atmosphere, representing over ⅛ of national emissions. Numerous projects have already sought to demonstrate the feasibility of capturing this carbon and sequestering it underground, or using it for enhanced oil production, but a number of innovative processes are emerging to use the carbon as a raw material for other products, including polymers, carbon fiber, chemicals, nanomaterials or fuels using a variety of methods. Conventional carbon capture systems can typically pull 80–90% of the carbon dioxide out of exhaust from combustion systems,[180] which means that there is a potential resource of hundreds of millions of tons of carbon dioxide which could potentially be used to make new products. The limiting factor will probably be the availability of processes to utilize the carbon and markets for the resulting products.

Bioplastics have been one of the first large-scale applications of biotechnology for the purpose of improving industrial sustainability. Dozens of alternative biobased polymers have entered the market, demonstrating the capacity to replace fossil carbon in a variety of applications and, in many cases, offering more sustainable recycling or reuse options than traditional equivalents. Around 1% of U.S. GHG emissions come from producing plastics. Switching from fossil-based plastics to corn-based biopolymers could reduce emissions by 0.6kg–1.4kg of CO_2 per kilogram of plastic.[181]* Widely applied, this could reduce emissions from plastic production by about 25%, totaling 16 million metric tons of CO_2 per year. Switching from corn to cellulosic feedstocks, like switchgrass, Miscanthus, or corn stover could double the emission benefits.[183]

Organic Waste Utilization

Researchers and policy makers are becoming increasingly aware of the need to more efficiently use materials in industry. This is particularly true of organic waste, like food scraps, agricultural residue and un-recyclable wood products, because they not only require fertilizer and other inputs to make those materials, but as they decompose, also emit carbon dioxide or, worse, methane. Anaerobic digestion (AD) is

*__Editor's note:__ there is no corresponding footnote reference for footnote 182. The reference as been incorporated herein as follows:

a well-understood technology for converting organic waste into energy, while recovering nutrients that can be returned to the soil. When decomposition happens in the absence of oxygen, microbes convert organic waste into biogas—a mixture of methane, carbon dioxide, water vapor and other trace components. This can be cleaned up to yield Renewable Natural Gas (RNG), which is mostly methane and functionally equivalent to fossil natural gas. AD produces not only this valuable product, but also solid digestate, which is very similar to compost and can be used as a beneficial soil amendment. By capturing the methane which would otherwise have been released into the atmosphere, AD further reduces the GHG footprint of organic waste disposal; in some cases the effect of preventing uncontrolled releases of methane can be so great that the resulting RNG is effectively carbon-negative, when evaluated by LCA.[180] Widespread deployment of RNG systems at landfills, wastewater treatment plants, livestock yards and other organic waste hotspots could displace enough fossil natural gas to offset 40–75 million metric tons of carbon dioxide emissions. Using agricultural residue or wood waste could add another 12–40 million metric tons, though these resources may have other competing uses in a low-carbon economy.[184]

Cleaner Buildings

There are opportunities to build sustainable, circular material cycles into more than just consumer products. Carbon can be pulled out of the atmosphere and used to make the very buildings, roads, and cities we live in. Wood, long thought of as a traditional building material, is enjoying new attention as a low-carbon solution for future construction. Since wood pulls carbon from the air as it grows, it represents a very stable and durable removal mechanism for atmospheric carbon, which will remain sequestered as long as the wood remains solid. Engineered wood products, including cross-laminated timber, fiber or polymer reinforced products, or wood composites can provide strength and durability previously thought possible only from metal. A recent study of engineered wood products found that they can reduce GHG emissions by 20% when substituted for fabricated metal, 25% for concrete and 50% for iron or steel. Engineered wood has been used to build several multistory demonstration buildings to show that high-rise construction is possible without conventional materials. A five-story wood building stores about 26 lb of carbon per square foot.[185] With over 350 million square feet of multifamily housing constructed in the U.S. in 2019, the potential carbon savings could be substantial.[186]

Another opportunity to find uses for carbon dioxide is in cement, which is currently one of the largest sources of greenhouse gas emissions in the world and was responsible for over 40 million tons of emissions in the U.S.[187] Researchers have been investigating alternative formulations of cement, which utilize carbon dioxide during production or absorb it from the air as it cures. By integrating these techniques with renewable energy to power the process, it is possible to end up with carbon-neutral concrete turning some infrastructure projects into net carbon sinks.

3.2.3 Developing Lower-Carbon Products

If humanity is to successfully avoid the worst impacts of climate change, it will have to find lower-carbon substitutes for many of its most important products. No product exemplifies this challenge better than transportation fuel. The ready availability of reliable, high-speed transportation is a foundational element of life in the U.S.; it is the lifeblood of modern supply chains and personal lifestyle. The U.S. is by far the biggest consumer of oil in the world, consuming almost 20 million barrels of crude oil per day, and processing it through more than 130 refineries into a wide range of fuels and petrochemical products, most importantly gasoline and diesel.[188] The emissions from vehicle tailpipes, plus the production and refining of petroleum total over 1,900 million metric tons of carbon dioxide equivalent each year, almost 30% of the U.S. total or about as much as Germany and Japan, combined.[189]

Neither the U.S. nor any other nation can halt climate change while depending on petroleum to fuel its transportation system. There is no single solution to this problem, a full portfolio of tools is needed. Light-duty vehicles, like cars, trucks, and SUVs consume the majority of petroleum in the U.S.; there is consensus within the transportation research community that replacing these with battery electric vehicles, charged on a grid dominated by renewables or other carbon-free sources, will by the primary way of reducing these emissions, with mass transit and other measures also playing a role. Many of the medium and heavy duty vehicles, like box trucks, delivery vans and some tractor-trailers will also be powered by electricity from batteries, or possibly hydrogen fuel cells.[190] There are some types of transportation, however, for which energy-dense liquid fuels will be much harder to replace. Aviation is the biggest of these; the U.S. consumed over 18 billion gallons of jet fuel in 2019,[191] and while the industry will take some time to recover from the ravages

of COVID–19, commercial air travel will continue to factor in global transportation. Some marine applications, long-haul trucking, military operations, backup and emergency power, and specialized vehicles may also need liquid fuels. The U.S. currently consumes around 15 billion gallons of ethanol per year, and around 2.5 billion gallons of biomass-based diesel substitutes including biodiesel and renewable diesel. The vast majority of ethanol is made from corn, while around [] of U.S. biomass-based diesel is made from soybean or canola oil, with the rest coming from waste oil or byproducts.[192]

Most of the biofuels currently used in the U.S. reduce carbon emissions when they displace petroleum fuels. Typical corn ethanol emits about 30% less carbon than gasoline, when the full life cycle of both products are considered, and typical biodiesel or renewable diesel from soybean oil reduces carbon by 40–50% over the full life cycle.[193] With domestic consumption of these fuels measured in the billions of gallons each year, these emission reductions represent millions of tons of avoided carbon. *The use of biofuels is estimated to have reduced U.S. transportation sector GHG emissions by 980 MMT CO_2 from 2009–2020.*[194] *This is equivalent to taking roughly 16 million vehicles off the road, or 19 coal-fired power plants offline, forthat 13 year period.*[195]

First-generation biofuels alone cannot meet the challenge of near-complete de-carbonization by mid-century, but have achieved critical near-term reductions as other low-carbon transportation solutions are being developed; and they form an important technological foundation for the next generation of low-carbon fuels. The biotech industry can leverage its capacity to innovate to help advance biofuels in two main ways, reducing emissions from current production and developing zero, or near-zero carbon fuels.

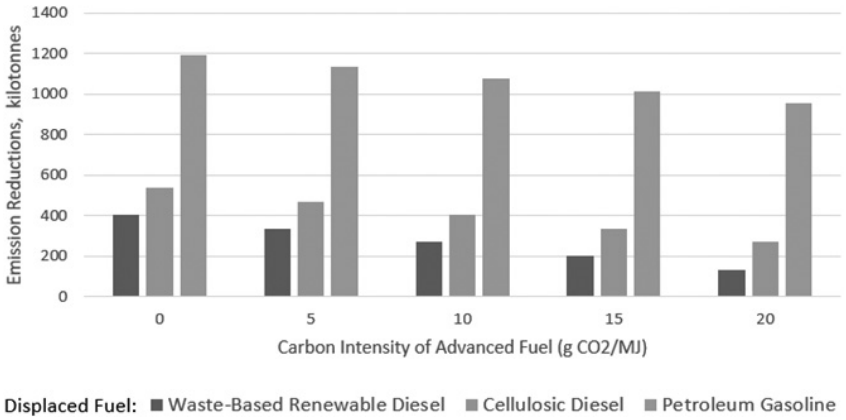
Reducing Emissions From Existing Fuels

The U.S. fuel ethanol industry operates around 200 production facilities spread across the U.S., representing tens of billions of dollars in capital investment and thousands of jobs.[196] While corn-based ethanol may struggle to achieve the very low-carbon levels needed in the long-term future, it has a critical role to play over the next few decades. As long as there is petroleum-based gasoline being consumed in the world, there will be value in producing a substitute that is 30% less carbon intensive; and the evidence suggests that the industry can reduce emissions even further. Driven in large part by the adoption of carbon intensity standards like California's LCFS, the ethanol industry has improved the efficiency of its facilities and found new ways to recover valuable co-products. Doubling down on these processes can continue to reduce emissions.

Improved efficiency of ethanol production facilities has reduced the energy inputs needed per gallon of output by a few percent per year,[197] and the industry has begun to utilize cellulosic processing technology to convert the previously indigestible corn kernel fiber into ethanol, increasing the yield from each bushel of corn by 3–4%. Improved crop yields and strains optimized for fuel production also help reduce the emissions associated with each unit of fuel. Incremental improvements like these seldom grab headlines, but on the scale of U.S. ethanol production, they add up. Each 1% improvement in average carbon intensity, across the entire U.S. ethanol industry results in around *800,000 metric tons* of avoided carbon dioxide emissions each year.[198] Similarly, there are opportunities to improve the efficiency of biodiesel and renewable diesel production, the latter of which anticipates almost a six-fold increase in U.S. production capacity over the next 5 years.[199] More efficient catalysts and purification systems can reduce the need for energy or reagent inputs, driving GHG emissions down even further. If the U.S. renewable diesel industry grows as anticipated, each 1% improvement in efficiency yields around *170,000 metric tons* of avoided emissions each year.[200]

Figure 2: Each 100 million gallons of advanced, low-carbon biofuel has the potential to displace as much as 1 million tonnes of carbon, if it displaces petroleum fuels, or over 200,000 tonnes if it displaces current-generation biofuels.

Potential Emissions Reductions From 100 Million Gal. of Advanced Biofuel



Source: California Air Resources Board.

Developing Zero or Near-Zero Carbon Fuels

Decarbonizing transportation will require a new generation of fuels. Cellulosic biofuels, which use inedible plant matter as their feedstock, offer the potential for much deeper reductions in carbon emissions.[201] Cellulosic biofuels have been on the horizon for many years, but technological and supply chain challenges sank several early projects. A new wave of cellulosic production facilities, promising 60–80% lower emissions than conventional fuels are under development and if early projects are successful, could be the start of a new, multi-billion gallon per year industry. One key difference between the first wave of cellulosic production facilities and this one is that rather than breaking down cellulose into sugars and fermenting them into ethanol like you would with starch, these facilities use heat to convert biomass into a gas, or light oils, then process those into finished fuels. There are numerous opportunities to further refine the process, however, by making more selective and durable catalysts, or providing feedstock which improves yields, is more easily handled or requires less pre-treatment.

Algae or other microbes may offer the greatest potential to deliver fuels that approach or achieve carbon neutrality. Algae can be grown using wastewater or even exhaust gas as their primary source of nutrients and can be tailored to produce highly desirable oils or carbohydrates at extremely high theoretical yields. Attempts to scale these systems up have run into problems with pathogens, competition from wild microbes and finding efficient methods to separate desired products from water and cell mass. If algal fuels, or other advanced synthetic fuels could be commercialized, they offer the potential for billions of gallons of a product that is compatible with existing vehicles and infrastructure. *Figure 2,* shows the potential emissions reductions from 100 million gallons of a hypothetical advanced fuel, at various carbon intensities.[202] Depending on what it displaces, the *emissions benefits could be a few hundred thousand to over 1 million metric tons each year*[.]

3.2.4 Enhancing Carbon Sequestration

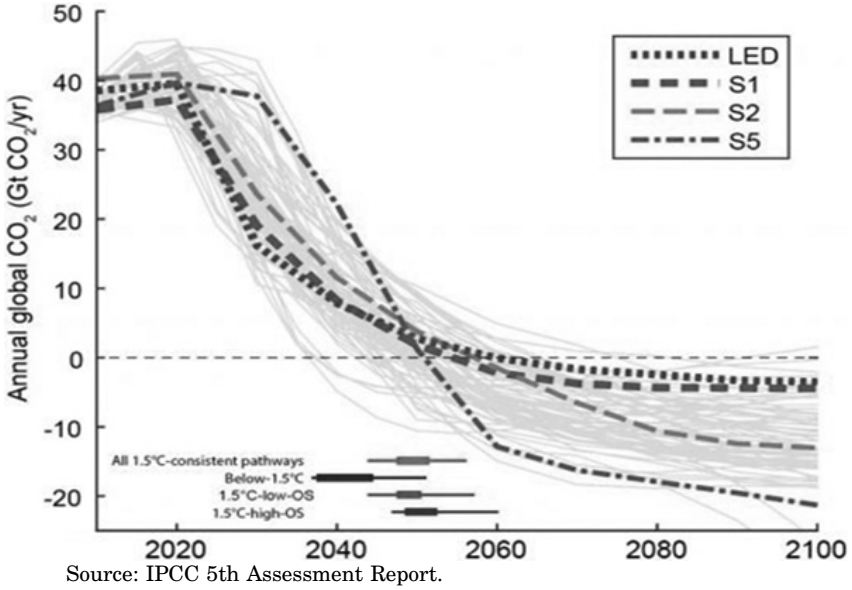
Enhancing Carbon Sequestration

Drastically reducing carbon emissions is necessary if humanity is to avoid the worst effects of climate change, but more will be needed. Almost every model of a successful stabilization of temperatures includes a large amount of carbon dioxide removal from the atmosphere, through enhanced plant growth and CCS. *Figure 3* shows results from the IPCC 5th assessment report regarding global carbon emissions trajectories that preserve a hospitable climate. Each line represents one simulation of the future in which average temperature increase is kept below 1.5 °C (the graph for a 2 °C outcome looks quite similar). In every case, net emissions must not only be reduced to zero, but the world will need to rapidly remove carbon from

the atmosphere over the second half of this century.[203] Biotech can provide crucial tools to help this effort.

It is difficult to estimate how much of an impact carbon capture might have on the climate system of the future; in some ways the sky is really the limit since there is certainly no shortage of carbon dioxide in the atmosphere to remove. Accelerated R&D and rapid deployment of demonstration projects will be necessary to identify and prove the capabilities of the many technological options which could contribute.

Figure 3



Source: IPCC 5th Assessment Report.

Bioenergy with Carbon Capture and Sequestration (BECCS)

Many of the most promising concepts for scalable carbon sequestration rely on photosynthesis to do the actual capturing of carbon dioxide, which can then be used or stored. One of the most promising is BECCS, which uses the biomass from plants to produce fuels or energy, storing carbon along the way. There are many proposed models for BECCS, from burning biomass in conventional power plants and capturing carbon from the exhaust, to gasification systems which leave behind carbon-dense biochar that can be used as a carbon-sequestering soil amendment. The energy or fuels produced by these systems would also help displace fossil fuels, providing a double climate benefit. A recent analysis estimated that, by 2040, BECCS could cost effectively remove over *700 million metric tons of carbon per year,*[204] or more than half the emissions from all U.S. coal power plants, though doing so would require a massive amount of sustainable biomass feedstock to be produced.

Sequestration in Natural and Working Lands

Natural ecosystems have been sequestering carbon for millennia without human assistance and should not be overlooked as a method of removing carbon from the atmosphere. The main mechanism of sequestration is through the growth of roots in the soil, accumulation of fallen organic matter, or the accumulation of organic matter at the bottom of oxygen-poor bodies of water. Most biomass decomposes or is consumed by animals but some, especially the hard-to-digest fibrous parts of plants composed of lignin and cellulose, remains in solid form for decades or more and is integrated into soil. Human encroachment on natural lands and climate change are affecting most natural ecosystems, often disrupting this process; but careful intervention, through things like managed replanting, selective breeding for sequestration potential, soil amendments such as compost or biochar, selective harvest and prescribed fire can increase the rate of carbon sequestration and build healthy, resilient ecosystems. The National Academies concluded that enhanced management of forests could sequester anywhere from a few hundred pounds to over a ton of carbon per hectare annually;[205] widely deployed this could result in

sequestration of *100 million metric tons of carbon per year, with an additional 150 million metric tons possible through expanding forested areas,* this would be like taking 20 to 50 million cars off the road.

Enhanced Weathering

While the majority of carbon removal from the atmosphere is done by plants, it is not the only mechanism. Certain types of mineral like olivine, serpentine and basalt will react with carbon dioxide to form stable carbonate minerals in a process known as "weathering". This mechanism has been largely responsible for mitigation of high atmospheric CO_2 concentrations in prehistoric times. Unfortunately, it is naturally quite slow, suited for geological rather than human time scales; but there are ways that it might be accelerated and scaled to help address the climate crisis. Olivine and serpentine are often found in discarded mine tailings or asbestos formations; basalt can often be found in geologically active areas, where geothermal power plants may be active. By managing air flow, moisture and pH levels in these sites, the rate of carbon uptake could be substantially increased. Adding catalysts, or microbial agents could increase the potential even further.

Direct Air Capture

Most carbon capture systems rely on natural processes to remove carbon from the atmosphere, but new innovative approaches may offer the opportunity to cut out the intermediate step. Several processes are being tested that use chemical solvents, such as amine or carbonate solutions, to absorb CO_2 from the atmosphere, and release it into a containment system, resulting in pure CO_2 that can then be sequestered underground or used to make products. Since CO_2 is only a few hundred parts per million in the atmosphere, this process requires a lot of surface area and usually uses heat to regenerate the solvent solution. This can make these systems bulky and energy-intensive. By developing more effective and durable solvents, or lower-energy regeneration processes, these systems could be made cheaper and more scalable. The upper limit of potential for these systems depends on how optimistic one is about the rate at which they will improve their energy and cost efficiency. Studies have projected the impact of direct air capture at anywhere from a few hundred million tons to more than half of today's global CO_2 emissions.[206]

4 Barriers to Adoption and Policy Proposals

4.1 Financing Barriers

Biofuels and bioproducts have historically faced a major commercialization hurdle in the form of access to financing. Biotechnology products that are intended to reduce GHG emissions must necessarily compete with fossil fuels that supply a well-established refining and petrochemicals production infrastructure. Whereas this fossil infrastructure is often decades old and has often been fully paid off by its owners, biotechnology products require investment in either new infrastructure or large-scale retrofits of existing infrastructure. These investments can be very expensive, with one review of announced commercial-scale cellulosic biofuel projects finding capital costs to be approximately $11/gallon of installed production capacity.[207] With the exception of large, established companies, few new producers have ready access to this amount of capital, necessitating that they access the capital markets through lenders and/or investors.

Private sources of capital generally require a demonstration that a biotechnology project can achieve certain levels of profitability in the form of a "hurdle rate" before providing access to financing. Biobased fuels and products compete with fossil fuels and products for market share, and the market value of the former operates as a function of the latter as a result. On occasion this has been advantageous for biotechnology products, such as when fossil fuel prices rose sharply in 2007–08. The steady decline of fossil fuel prices that has occurred over the last decade in response to increased unconventional production of natural gas and petroleum in the U.S. has made it more difficult for biotechnology products to obtain the necessary hurdle rates for financing, however, even as climate change has become an important concern for American consumers.[208] Likewise, the immediate financial incentive to make investments in energy efficiency and other marginal reductions to GHG emissions is limited when energy costs are low.

A challenge faced by biofuels and bioproducts is that many of the advantages that they offer over fossil fuels are not reflected in their market value. For example, in addition to the GHG emissions reductions discussed above, many biotechnology products achieve low levels of other types of pollution such as particulate matter emissions, sulfur emissions, water contamination, and toxic waste production compared to fossil fuels. These reduced impacts on human health and the environment have a clear monetary benefit in the form of reduced spending on medical services,

environmental remediation, recovery from extreme weather events, *etc.*[209] Moreover, biotechnology provides the ability to reduce GHG emissions and other forms of pollution across a variety of economic sectors, including agriculture, manufacturing, and transportation. Such benefits are not reflected in the market value of the biotechnology products, however, placing them at a competitive price disadvantage to fossil fuels.

Governments have sometimes enacted policies that cause the benefits of biofuels and bioproducts to be reflected on the marketplace, either by subsidizing those biotechnology products that have reduced impacts on human health and the environment or by increasing the cost of fossil fuels (see Section 4.3). Some, such as California's LCFS, have prompted rapid growth in the use of biofuels by subsidizing biofuels, especially those from second-generation feedstocks, based on the degree to which they reduce transportation GHG emissions.[210] The LCFS recently expanded to provide support for CCS; when combined with Federal 45Q tax credits, this can offer over $150/tonne of total incentive for project developers.[211–212] Government incentives in the U.S. have not always been sufficient to make biotechnology products competitive with inexpensive fossil fuels, though: one recent analysis calculated that new cellulosic biorefineries would struggle to be financially viable despite the presence of supporting Federal policies because of the low fossil fuel prices that have prevailed since 2014.[213] Producers of biotechnology non-fuel products, for which government support mechanisms are fewer, have also faced high hurdles to private financing.

Some producers of U.S. biofuels and bioproducts have been able to obtain public financing in the form of loans, loan guarantees, and grants from the Federal and state governments. The U.S. Department of Agriculture offers loan guarantees of up to $250 million for the building of capacity for the production of specific biotechnology products including advanced biofuels and biobased chemicals.[214] The loan guarantee program was started in 2008 to enable financing of advanced biofuels and was expanded in 2014 to cover other bioproducts as well. The loan guarantee reduces the barriers to obtaining private financing by having the U.S. Government backstop qualifying loans to producers. While this backstop does not guarantee private financing for the facility, it substantially reduces the producer's financing hurdle rate by reducing the risk of default on any loan covered by the guarantee. Several states operate their own direct loan and loan guarantee programs for biorefineries, albeit on a smaller scale.[215]

Grants are another public finance mechanism that has supported the commercialization of biotechnology. Unlike direct loans and loan guarantees, grants are one-time awards of financing that are not repaid. The awards generally involve smaller amounts of financing than are provided via direct loans and loan guarantees, and they have often been used to support R&D or make improvements to existing facilities rather than to build a new commercial-scale facility. One example is the Value-Added Producer Grants program administered by the U.S. Department of Agriculture, which "helps agricultural producers enter into value-added activities related to the processing and marketing of new products."[216] Other grants indirectly support the establishment and commercialization of biofuels by being directed toward the upgrading of infrastructure that is downstream of production facilities and improving consumer access.

The private and public capital that has been invested into biobased fuels and products has spurred the commercialization of low-carbon technologies since the turn of the century. Investments have fallen far short of what is necessary to avert catastrophic climate change, however, reflecting the major hurdles to financing that still exist within the biotechnology industry. The IPCC estimates that $2.4 trillion in annual investment is needed globally in the energy sector alone until 2035 to limit temperatures to no more than 1.5 °C above pre-industrial levels.[217] This number is larger still if the de-carbonization of non-energy sectors such as agriculture and materials are accounted for. Actual global low-carbon energy investment in 2019 was only $0.6 trillion, or 25% of what is needed.[218] Additional policy mechanisms will be required to rapidly reduce existing hurdles to the financing of biobased projects. Governments will also need to reduce the regulatory barriers that these projects face, as unfavorable regulatory environments increase the financial risks that they bear and their hurdles to financing.

4.2 Regulatory Barriers

The biotechnology industry plays an important role in developing and commercializing novel products that are not always directly compatible with the existing infrastructure in the sectors into which they are introduced. Moreover, many of these products are manufactured using technologies such as gene editing that are closely regulated by national governments. These factors have resulted in the forma-

tion of multiple regulatory barriers that hinder the adoption of low-carbon biofuels and bioproducts and constrain the biotechnology industry's ability to reduce emissions of GHGs and other pollutants.

Biotechnology Regulation

GMOs have had a long and contentious regulatory history in the U.S. Since 1986, biotech products in the U.S. have been regulated under the *Coordinated Framework for the Regulation of Biotechnology* (*Coordinated Framework*).[219] The framework has been updated several times since its introduction, including a comprehensive revision in May 2020, known as the Sustainable, Ecological, Consistent, Uniform, Responsible, Efficient (SECURE) rule, or Part 340 rule, which significantly streamlined and modernized the regulatory framework.[220] While U.S. regulators and consumers are relatively accepting of GMO products, societal opposition to the use of GMOs in the agriculture sector in particular has, on occasion, prompted a cautious response to new GMO products by regulators that has slowed the introduction of biotech products to the market.

Regulations in other regions, such as Europe, are more hostile,[221] hampering the ability of the U.S. biotechnology market's products to make an outsized contribution to global GHG emission reductions. For example, as discussed in Section 1.4, GMO food crops have enhanced resiliency under the types of extreme weather conditions that are becoming more common as the climate changes, thereby reducing the amount of land required by agriculture and reducing the incentive to increase GHG emissions via land-use change.

Studies have found that Americans, including those residing in states with large agricultural sectors, have concerns about the production of bioenergy from GMO feedstocks as well.[222] Some second-generation bioenergy feedstocks have attracted opposition due to their use of fast-growing and potentially invasive forms of biomass. These feedstocks, especially those that have been genetically engineered to expand rapidly, have prompted concerns that they could expand into and damage the surrounding ecosystem.[223] Notably, though, biotechnology has also provided a means of potentially overcoming this barrier. In one recent research breakthrough, microalgae grown as a biofuels feedstock has been genetically engineered to be unable to survive outside of the production facility, thereby preventing its uncontrolled growth.[224]

Genetically engineering microorganisms used in the production of fuels, chemicals and other products are also subject to Federal regulation, but their place in the Coordinated Framework has long been unclear, and GE microbes were not clearly addressed in the SECURE rule. This regulatory uncertainty is likely to present a significant barrier to the development and commercialization of biotech climate innovation.

Regulation of Fuels and Products

A second major regulatory barrier is posed by conflicting state policies on certain biotechnology products. While the U.S. has a comparatively more integrated common market than the European Union, individual state governments sometimes have policies in place that discourage the introduction of biotechnology products into entire regions, let alone individual markets. This situation can prevent the adoption of products that have interstate supply chains. One example that is already occurring involves the transport of renewable diesel through existing refined fuels pipelines. Renewable diesel is a drop-in biofuel that can utilize cost-effective distribution infrastructure such as the refined fuels pipelines that connect refineries to multiple states' markets (*e.g.,* the Colonial Pipeline in the Southeastern U.S.). Many states require that the biofuels content of fuels retailed within their borders be stated on a fuel pump label, but this is not easily known if the renewable diesel is being pipelined in a blended form with diesel fuel. The result is that having even a single state on an interstate pipeline with strict pump labeling requirements can discourage the movement of a drop-in biofuel such as renewable diesel through it. The biofuel must instead be transported by rail, ship, or truck, all of which are more expensive and polluting options than pipeline.[225]

Biotechnology products that are not compatible with unmodified existing infrastructure often face a heightened regulatory barrier. U.S. ethanol consumption has historically been constrained by the so-called "ethanol blend wall", which refers to the maximum blend that can be used in existing infrastructure. Ethanol is a hydrophilic fuel that is miscible with water, and this trait prevents its movement through pipelines at any blend rate and use in unmodified engines above specific blend rates due to the potential for water contamination. Ethanol blends for use in unmodified engines were limited to 10% by volume (E10) until 2011, when the U.S. Government began to allow blends of up to 15% by volume (E15) during certain seasons of the

year.[226] The unrestricted sale of E15 was not permitted until 2019.[227] The blend limits apply to ethanol whether produced from corn or lignocellulosic biomass, and the blend wall sharply constrained fuel ethanol demand from all feedstocks beginning in 2013 as a result.[228]

The U.S. Government has also used regulatory changes to restrain demand for all biofuels since 2017. National biofuels demand over the last decade has been driven by the revised Renewable Fuel Standard (RFS2), which mandates the annual consumption of specific volumes of different types of biofuels. Petroleum refiners are tasked with ensuring that sufficient quantities of biofuels are blended with refined fuels to comply with the mandate, and a refiner's individual blending quota is determined by its market share. Between 2017 and 2019 the Federal Government greatly increased the number of hardship waivers that it awarded to refiners, reducing their blending quotas and overall demand for biofuels under the mandate.[229] One analysis calculates that the increased number of hardship waivers awarded caused demand for advanced biofuels under the mandate to be up to 1 billion gallons lower per year, and that the amount of the annual reduction has equaled as much as 50% of U.S. production.[230]

Regulatory barriers can be particularly high for truly novel biotechnology products due to a lack of suitable regulatory frameworks. Cultured meat, for example, has been identified as one product for which existing U.S. regulations are inadequate due to the existence of myriad production techniques and the potential for genetic modification as part of the production process.[231] Regulatory uncertainty is as much of a barrier as adverse regulation is, inasmuch as both discourage financiers from providing the capital necessary for commercialization. The lack of an adequate regulatory framework also raises the possibility that adverse regulation could result from a regulatory rulemaking process.

The future growth of the U.S. biotechnology industry will be heavily affected by existing and potential regulatory barriers. One recent analysis estimated that 50% of the total economic impact of biotechnology over the next decade "could hinge on consumer, societal, and regulatory acceptance" of the industry's products.[232] The analysis further calculated that this amount increases to 70% over the next 2 decades. This has important implications for the ability of biotechnology to provide climate solutions given that early emissions reductions are more valuable than later reductions. The continued presence of regulatory hurdles is an especially pressing issue given the major shortfall of de-carbonization investments (see Section 4.1).

4.3 Policy Proposals

The growing recognition by many U.S. policymakers that existing efforts to decarbonize the country's economy are falling short of its commitments under the 2015 Paris Climate Agreement has led to the unveiling of a variety of climate policy proposals at the Federal, state, and local levels of government. These proposals fall into two broad categories: the first category focuses on the de-carbonization of individual sectors while the second category instead takes an economy-wide approach. The sector-based proposals are similar to policies already in place in states such as California, whereas the economy-wide proposals are more novel and less well established. An aggressive combination of sector-based and economy-wide policies is needed to rapidly realize the full potential of biotechnology to combat climate change.

4.3.1 De-carbonizing Transportation

The first 2 decades of the 21st century saw the introduction of several policies to reduce the carbon intensity and GHG emissions of the transportation sector. Some, such as Federal RFS2 and California LCFS, were successfully implemented and have resulted in the partial de-carbonization of the on-road transportation sectors in their respective jurisdictions through the increased use of biofuels. But regulatory implementation of these policies has, particularly in the case of RFS2, limited their impact. *Barriers to the full implementation of existing Federal renewable fuels policies should be removed and aggressive follow-on transportation sector climate policies adopted to achieve the maximum near-term and longer-term GHG reductions.*

Renewable Fuel Standard

The continued presence of the RFS2 as the centerpiece of U.S. transportation sector de-carbonization efforts has had an important impact on the development of intermediate-term GHG emission reduction strategies, with cumulative reductions of 980 MMT CO_2 since RFS2 was enacted.[233] But a series of EPA regulatory actions has substantially limited the program's climate gains. The agency has repeatedly reduced RFS volume obligations and has issued a growing number of small refinery waivers, further reducing the market for biofuels in the U.S.[234]

EPA has taken some steps to expand U.S. biofuels markets. The ongoing effort to expand the volume of ethanol permitted by the ethanol blend wall is one example of this trend (see Section 3.2). Following on earlier efforts to ease restrictions on E15 consumption, in 2020 the Trump Administration announced that the Federal Government would not block the use of E15 in fuel pumps that were compatible with E10 (although state governments are still able to do so).[235] The complete replacement of E10 consumption by E15 would increase the amount of fuel ethanol consumed in the U.S. by 50%. While the magnitude of the associated transportation sector emissions reduction would depend on the feedstocks being used, any increase to E15 consumption would contribute to the sector's de-carbonization. *Additional actions to expand U.S. biofuel markets and establish greater RFS program certainty are needed to maximize near-term climate gains.*

Low Carbon Fuel Standard

The success of California's LCFS and a lack of Federal action on climate policy after 2016 has prompted similar policies to be proposed in other states. Oregon adopted a LCFS under its Oregon Clean Fuels Program that mandates a 10% reduction to the carbon intensity of its transportation sector from 2015 levels by 2025.[236] Efforts to implement a statewide LCFS in neighboring Washington are ongoing despite the failure of an earlier attempt.[237] Similar regional initiatives have been proposed in the Midwest [238] and East Coast,[239] although legislative action on these proposals has yet to occur.

Efforts to implement a national LCFS date to 2007, when then-U.S. senator Barack Obama introduced a bill to require future reductions to the carbon intensity of the U.S. transportation sector.[240] While that proposal was ultimately discarded in favor of legislation that created the RFS2, the U.S. House Select Committee on the Climate Crisis recently recommended that the RFS2 be transformed into a national LCFS.[241] That recommendation also included a provision to expand the remit of the RFS2 to include shipping and aviation fuels, in addition to on-road transportation fuels, as part of the transformation. The success of California's LCFS and steps by other states to adopt similar programs suggests *the time has come for a Federal low-carbon fuel standard.*

Other Fuel Policies

In addition to market-driving programs such as the RFS and LCFS, ongoing Federal and state investments in the improvement of existing biofuels and the development of next-generation biofuels are recommended to achieve the greatest near-term climate benefit. *Robust Federal investment in biofuel research and development at the U.S. Department of Energy and USDA and long-term tax credits or other incentives for private-sector biofuel research and development and facility construction are recommended to help drive additional private-sector investment in low-carbon fuels.*

The development of a long-term sustainable aviation fuel specific blender's tax credit will attract significant investment to the sector, address existing structural and policy disincentives, and ramp up domestic SAF production to meaningful levels.. Further continuation of the Second Generation Biofuel Producer Tax Credit is incredibly important to companies that are making significant investments to create new agricultural supply chains, build infrastructure for liquid biofuels, and develop innovative new technologies.

4.3.2 De-carbonizing Industry

Policy has historically favored the production of biofuels over other forms of biobased products. Renewable chemicals and other non-fuel biobased products that achieve GHG emission reductions, such as those described in Section 2, will need to be supported if sectors outside of transportation are also to be successfully Dearborn. Several potential mechanisms exist for achieving this result, some of which build upon existing policy frameworks and others that employ more novel approaches.

Renewable Chemical and Biobased Product Programs

The U.S. Government operates two important farm bill energy title programs, the BioPreferred Program and the Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program, that support the commercial development of renewable chemical and biobased product manufacturers. These producers continue to face substantial hurdles to commercialization due to the lack of an even playing field with producers of competing products from fossil fuels.

The BioPreferred Program, originally authorized under the 2002 Farm Bill and reauthorized and expanded under the 2018 Farm Bill, includes a Federal biobased product procurement preference program and a voluntary USDA labeling program

for biobased products.[242] These programs have significantly increased both consumer awareness and market demand for biobased products. The 2018 Farm Bill provided increased funding for BioPreferred and, among other provisions, directed USDA and the Department of Commerce to develop North American Industry Classification System (NAICS) codes for renewable chemicals and biobased products.[243] The 2020 National Academies of Science report on "Safeguarding the Bioeconomy" cites the lack of an industry classification system for biotech products as a significant roadblock to investment and broader adoption, and recommends a series of actions to fill this gap.[244]

The Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program (BAP) provides loan guarantees for the development, construction, and retrofitting of commercial-scale biorefineries.[245] The 2018 farm significantly expanded and streamlined the BAP loan program.

The Commerce Department and USDA should move swiftly to implement biobased product classification systems, and Congress should fully fund BioPreferred and the BAP loan program.

Tax Policy

Tax policy has been a vital early driver of biofuel and other renewable energy development. Several recent policy proposals seek to provide a similar push to non-fuel biobased products. A proposed change to Federal tax law would enable producers of biobased products to utilize the Master Limited Partnership pass-through tax structure that is widely employed by fossil fuel producers to improve access to capital and reduce tax burdens.[246] Such an expansion has been employed in the past in the U.S. to support the development of renewable electricity and biofuels logistics infrastructure, making its absence in the biobased products sector particularly notable. Federal legislation to expand existing business-related and investment tax credits to include renewable chemicals production has also attracted bipartisan support in Congress,[247] although it has yet to become law.

U.S. tax policy should be updated to extend renewable energy tax incentives to renewable chemicals and biobased products.

4.3.3 De-carbonizing Agriculture

One of the most important mechanisms available to leverage biotechnology for climate mitigation is agriculture policy. As discussed in section 2, the carbon intensity of industrial products is highly dependent on the carbon intensity of feedstocks. Substitution of biobased feedstocks for fossil feedstocks is an essential step, but the greatest gains are achieved when climate objectives are integrated into the production of the feedstocks themselves, internalizing the environmental benefits that are provided by producers of biobased products, especially those that operate within the agricultural sector.

One such proposal would expand farm bill programs such as the Conservation Stewardship Program, which encourages producers to undertake conservation activities on working lands,[248] to include practices that decrease the carbon intensity of agricultural production while increasing crop yields. Likewise, the existing section 45Q tax credit for certain CC&S technologies could be expanded to encompass the building of soil carbon in the U.S. agriculture sector.

The agriculture sector faces high barriers of entry to voluntary carbon credit programs that prevent their full carbon sequestration potential from being recognized. Federal legislation such as the Growing Climate Solutions Act of 2021 has been introduced as a means of enabling the private-sector to overcome these hurdles,[249] but Federal agencies could also provide additional support by expanding existing agricultural conservation programs and creating agricultural sequestration certification programs.

Congress and the White House should move swiftly to implement programs to reward farmers for reducing the carbon footprint of feedstock production and for capturing and sequestering carbon.

4.3.4 Negative-Carbon Technologies

To achieve agreed upon climate mitigation objectives, a major focus of climate policy must be investment in negative-carbon technologies. This will require policies that drive carbon capture, use and storage throughout the economy, including in agriculture and manufacturing. This should include sector-specific programs in each of these areas. *Climate policy should drive investment in agricultural biologicals, plant biotechnology and other biotechnologies to increase soil carbon sequestration and should reward microbial carbon capture and other biotechnologies for carbon removal and recycling.* Provisions for biological carbon capture and use in the section

45Q tax credit provide a template for inclusion of these technologies in future climate policy.

4.3.5 Economy-Wide Climate Programs

The U.S. transportation and power sectors have been the primary focus of policymakers due to their large share of total U.S. GHG emissions (28% and 27%, respectively, in 2018).[250] Several states have adopted more ambitious long-term policies that require the full de-carbonization of their economies by 2050, however, and the remaining sectors (industry, commercial/residential, and agriculture) will need to achieve future carbon intensity reductions greater than those that have been achieved by the power and transportation sectors to date if these policies are to be successful.

The first such state policy to be implemented was California's Global Warming Solutions Act of 2006, which mandated an economy-wide emission reduction of 80% by 2050.[251] In 2018 California's governor issued an Executive Order that changed this target to 100% on a net basis by 2045.[252] Equally ambitious is the New York Climate Leadership and Community Protection Act (CLCPA). Passed in 2019, the CLCPA requires that the state's economy-wide emissions by reduced by 100% by 2050,[253] although up to 15% of the reduction can take the form of offsets such as those described in Section 2.2. Colorado, Connecticut, Maine, Massachusetts, Minnesota, Nevada, Rhode Island, and Washington also all have statutory targets requiring statewide GHG emission reductions of at least 80% by 2050.[254]

A notable aspect of the deep economy-wide de-carbonization targets is that they will likely require the widespread deployment of carbon-negative technologies and non-fuel bioproducts in order to be successful. Policy language referring to "net zero" emissions targets or, in the case of New York, explicit carbon offset thresholds reflects the recognition of this probable outcome by policymakers. Existing state de-carbonization requirements also identify varying degrees of de-carbonization difficulty for different economic sectors. New York's statutory target, for example, imposes an absolute zero-emission target on its power sector by 2040 through language that explicitly excludes the use of carbon offsets by that sector. The reason for this distinction is the expectation that zero-emission technologies such as solar PV and wind will enable an absolute zero requirement to be achieved. Those sectors such as transportation and manufacturing that utilize more energy-intensive systems, by contrast, will need to rely upon biomass and biotechnology to achieve net-zero emissions, sometimes via carbon-negative technologies, while supplying close substitutes for the fossil fuels and products that modern economies rely upon.

Existing government efforts in the U.S. to incentivize de-carbonization have largely been limited to the transportation sector, whereas the implementation of performance-based de-carbonization standards in manufacturing would enable the broad scope of biotechnology's benefits to be recognized by the market. Such standards include, but are not limited to, financing R&D, promoting alternatives to non-fuel fossil products, supporting and expanding sustainable procurement policies, and incentivizing the development of green manufacturing and sustainable agriculture practices.

Recent years have seen only limited action at the Federal level to encourage the utilization of biotechnology's de-carbonization potential. Several states have adopted more ambitious long-term economy-wide de-carbonization targets, however. While the policy mechanisms to achieve these targets have yet to be established, their success will likely depend on the extent to which the policies properly value the de-carbonization, including net carbon sequestration, abilities of both fuel *

Summary and Conclusion

> "Climate change will affect every person, nation, industry, and culture on Earth."

Avoiding its worst effects will require an equally universal response. The biotechnology industry is uniquely positioned to play a leading role in the effort to reduce emissions, adapt to new climate conditions, and address the needs of the 21st century and beyond. In this report, three key themes have emerged. These themes should guide policymakers—and the biotech industry itself—if we are to achieve the full potential of biotechnology to address climate change.

Biotechnology is an essential climate mitigation tool. Biotech has already delivered vital climate solutions and holds the potential to provide transformative climate technologies across a broad spectrum of industrial sectors.

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* **Editor's note:** the paragraph is not completed in the submitted report. It has been reproduced herein as submitted.

Biotech can achieve at least 3 billion tons of CO_2 equivalent mitigation annually by 2030 using existing technologies. The biotechnologies with the greatest potential impact include:

- Biotech solutions have the potential to reduce agriculture sector GHG emissions by nearly 1 billion metric tons (1 gigaton) annually—or the equivalent of GHG emissions from more than 100 million U.S. homes. This includes reducing nitrous oxide emissions from agriculture by over 150 million metric tons of carbon equivalent and enhancing soil carbon sequestration by up to 600 million metric tons per year through a combination of agriculture biotechnology and agricultural biologicals.
- The transition to next-generation biofuels enabled by biotechnology will double the per-gallon emissions reductions of biofuels *versus* petroleum. Doubling biofuel use through broad adoption of next-generation biofuels in aviation and other transportation sectors would increase the contribution of biofuels to U.S. transportation sector GHG emissions reductions from 980 million tons over the past thirteen years to over 1.8 billion tons for the decade 2020–2030, a reduction equivalent to taking more than 45 coal-fired power plants offline.
- Broad adoption of algal and microbial feed ingredients that reduce enteric methane emissions from ruminant animals can avoid the equivalent of up to 140 million metric tons of carbon annually.
- Broad adoption of anaerobic digestion for animal waste would reduce U.S. GHG emissions by over 150 million metric tons annually using current technology.
- Bioenergy with Carbon Capture and Sequestration (BECCS) could cost-effectively remove over 700 million metric tons of carbon per year, or more than half the emissions from all U.S. coal power plants.
- Suitable land and other infrastructure exists to deploy algae-based carbon capture systems at more than 500 power plants and ethanol facilities in the U.S. These systems would have a potential to capture more than 200 million tons of CO_2 annually.

Emerging biotechnologies could have transformative GHG benefits in a range of industrial sectors. Among the most promising applications are:

- Biobased plastics and polymers, such as PLA, PHA, and BDO have achieved lifecycle GHG reductions of up to 80% *versus* their petroleum-based counterparts. A rapidly growing list of new biobased chemical building blocks is now in development.
- Plant-based and cultured meats are providing new consumer choices and up to 89% lower lifecycle emissions for a global food sector responsible for more than ⅓ of total GHG emissions.
- Biology-based parallel computing and DNA data storage have the potential to cut the energy and carbon footprints of computing and data storage—sectors expected to account for 14% or more of global GHG emissions by 2040—by 99% or more *versus* current technology.

Biotechnology offers vital contributions to near-term GHG reductions and revolutionary tools to combat climate change in the longer term. To successfully address the challenge of climate change, humanity will need to predominantly de-carbonize the global economy by mid-century and begin significantly drawing down concentrations of atmospheric carbon shortly thereafter. The struggle against climate change must be viewed as a multi-decade process, which needs to begin immediately. A ton of carbon emissions avoided now matters more than a ton avoided next year, but every step needs to be evaluated from the perspective of maintaining a trajectory towards success.

An aggressive combination of sector-based and economy-wide policies is needed to rapidly realize the full potential of biotechnology to combat climate change. The future growth of the U.S. biotechnology industry will be heavily affected by both existing and potential regulatory barriers, and by the degree to which governments invest in the development and deployment of biotech solutions. Biotechnology is a vital component of the national and global infrastructure needed to combat catastrophic climate change. The economy-wide scope of this challenge will require the adoption of policies that reflect the ability of biotechnology products to achieve decarbonization across all major sectors of the U.S. economy. Biotechnology companies will need to speak up not only to ensure that new policy provides opportunities for success, but to make it clear that prosperity is not threatened by sustainability. There is ample evidence that reducing emissions is, in fact, essential in supporting a thriving economy.

The biotechnology industry has a tremendous opportunity to build upon decades of success, and provide critical tools and expertise for the decades to come. Like every other industry, change will be profound and lasting, but if any industry can demonstrate that change can be an opportunity for growth, it is this one.

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[250] *http://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.*
[251] *http://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006.*
[252] *http://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf.*
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SUBMITTED LETTER BY DONNELL REHAGEN, CHIEF EXECUTIVE OFFICER, NATIONAL BIODIESEL BOARD

November 16, 2021

Dear Chairman Delgado, Ranking Member Fischbach, and Honorable Subcommittee Members,

Thank you for considering the testimony of America's clean fuel producers, who play a pivotal role in the U.S. bioeconomy.

The National Biodiesel Board (NBB) represents the cleanest, lowest carbon fuels available at a commercial scale today for use in existing diesel engines and in many of the hardest-to-de-carbonize transportation sectors. Our members include biodiesel, renewable diesel, Bioheat® fuel, and sustainable aviation fuel (SAF) producers as well as soybean growers and waste fats and oil processors. NBB is the industry's central coordinating entity for technical, environmental, and quality assurance programs and the strongest voice for its advocacy, communications, and market development.

Jobs and Economic Growth

The U.S. market today uses more than 3 billion gallons of these clean fuels—which supports more than 65,000 jobs across the country and generates more than $17 billion in economic opportunity. Our industry is on a path to sustainably grow domestic production to 6 billion gallons annually by 2030, which can eliminate more than 35 million metric tons of greenhouse gas emissions each year. Every 100-million-gallon increase in U.S. production supports an additional 3,200 jobs and $780 million in economic activity and can eliminate an additional metric ton of greenhouse gas emissions each year.

With advancements in feedstock, the market can reach 15 billion gallons by 2050. The United States will need these fuels in the future to meet the nation's clean air, energy, and agriculture goals—which are also the goals of the bioeconomy.

Our industry includes many small biodiesel producers in addition to large, integrated companies. In many rural areas of the country, small biodiesel plants are a driving force of the local economy, supporting the employment of plant operators, technicians and engineers as well as local construction workers, truck drivers and farmers. The economic opportunities and rural community development demonstrate biodiesel's potential to contribute to the rural, renewable economy.

Value Added to Other Bioeconomy Sectors

Our industry's clean fuels are made from an increasingly diverse mix of resources, including recycled cooking oil and animal fats as well as surplus soybean, canola and distillers corn oils. Our fuels add value to fats, oils and greases that might otherwise lead to costs for other sectors of the bioeconomy.

For example, soybean oil is separated from soybean meal through oilseed crushing. Demand for the meal as a high protein animal feed drives growth in soybean production, which reached 4.4 billion bushels in the current marketing year. This growth creates an ever-increasing surplus of oil.

About 60 percent of the separated oil is currently used in U.S. food production, with some additional exports. However, the volume of oil for food and exports has been stable over the past decade without any growth. Biodiesel and renewable diesel producers are currently the only commercial-scale industry capable of absorbing the growing surplus of soybean oil. Approximately half of the biodiesel produced in the U.S. comes from soybean oil.

Traditionally, roughly half of all U.S.-grown soybeans have been exported each year—and crushed overseas—to meet animal feed demand. Instability in these markets—including trade wars—combined with growing markets for renewable fuels in the United States are encouraging investment in more U.S. crush capacity to keep the value of soybean oil here at home.

StoneX estimates that without biodiesel and renewable diesel production, the value of every bushel of soybeans grown in the United States could fall as much as 13 percent. Growth in biodiesel and renewable diesel production is enhancing the value of soybean oil to an increasing share of the value of the overall bushel. The

bottom line is that farmers receive better value for their soybeans thanks to their partnerships with biodiesel and renewable diesel producers.

Rural livestock producers also benefit from increased biodiesel production. By boosting the value of surplus soybean oil—which would otherwise represent a loss to crushers—biodiesel production provides a counterweight to the price of soybean meal and the cost of raising poultry and livestock. As more surplus soybean oil is processed for biodiesel production, farmers can grow and crushers can process more soybean meal for animal feed at a lower price. Informa Economics has estimated livestock producers pay $21 per ton less for soybean meal due to increased biodiesel production and use.

Approximately ¼ of all animal fats produced in the U.S. now go into biodiesel. Higher demand has led to increased value for those fats. While the price of animal fats are not primary drivers in determining the prices paid for fed cattle and market hogs, they do affect the profit margins in these industries.

Similarly, restaurants and other businesses must engage environmental service firms to handle used cooking oil, which is designated by the Environmental Protection Agency as a hazardous waste. By adding value to recycled cooking oil, biodiesel and renewable diesel production provides a counterweight to the costs for restaurants and environmental service companies to meet these regulations.

Environmental Health Contributions

Clean fuel production contributes to the bioeconomy by reducing the impacts and costs of carbon and particulate emissions. Biodiesel and renewable diesel reduce greenhouse gas emissions on average by 74% compared to petroleum diesel. In difficult-to-de-carbonize transportation applications—the majority of diesel end-uses—these clean fuels immediately and substantially reduce greenhouse gas emissions. Additionally, they significantly reduce criteria pollutants from diesel transportation and other end-uses, which can have direct benefits for both rural and urban communities.

Biodiesel and renewable diesel have reduced U.S. emissions by 143.8 million metric tons since 2010, when the Renewable Fuel Standard first included biomass-based diesel obligations. These fuels have also made significant contributions to the carbon reduction goals of many states. For instance, California's total biodiesel and renewable diesel volume grew to 855 million gallons in 2020, meeting nearly 24% of California's total diesel demand for the year. These fuels have reduced the state's greenhouse gas emissions by 32.3 million metric tons since 2011.

In the Northeast, biodiesel and Bioheat® fuel will be required to meet the states' carbon reduction goals. Currently, one in five existing homes in the Northeast (around 4.5 million) rely on oil heat, using more than 2.3 billion gallons yearly. The region's biodiesel and Bioheat® fuel use annually avoids more than 1.5 million tons of CO_2 emissions, equivalent to removing 320,000 vehicles from the road or the emissions from annual energy use by 180,000 homes.

In addition to having one of the lowest carbon intensities of any liquid fuel, biodiesel also significantly reduces criteria pollutants from diesel transportation and other end uses. Major trucking corridors, warehouse distribution centers and other diesel hot spots close to population centers (often rural communities) can inflict serious harms to human health and often highlight disparities in the impacts of transportation pollution burdens as a result of emissions from petroleum fuel. Since biodiesel and renewable diesel cut these harmful emissions by half, their use can generate immediate health benefits for rural and disadvantaged communities.

A recent study, conducted by Trinity Consultants for NBB, shows that converting from petroleum-based diesel to 100 percent biodiesel (B100) results in a multitude of health benefits at the neighborhood level, including lowering cancer risk, reducing premature deaths, and decreasing asthma attacks. The study quantifies public health benefits and corresponding economic savings of converting from petroleum-based diesel to B100 for 13 disadvantaged communities in the U.S. currently exposed to some of the highest rates of petroleum diesel pollution.

The study found that switching to B100 in the home heating oil and transportation sectors would provide immediate community health improvements that can be measured in reduced medical costs and health care benefits, including approximately 50,000 fewer sick days in the study demographics.

In the transportation sector, benefits included a potential 44 percent reduction in cancer risk when heavy-duty trucks use B100, resulting in 203,000 fewer or lessened asthma attacks for the communities studied. When biodiesel is used for home heating oil, the study found an 86 percent reduced cancer risk and 17,000 fewer lung problems for the communities studied.

These are benefits that can be achieved today with available production of biodiesel, renewable diesel and Bioheat® fuel. Since the study focused on only 13 com-

munities, it represents the tip of the iceberg in what can be accomplished this decade through growth of the clean fuels industry.

Supportive Federal Policies

As Congress develops legislation to address the nation's infrastructure, climate and economic priorities, we ask that you support continued growth of the biodiesel and renewable diesel industry as a pivotal driver of economic opportunities for rural America. The Renewable Fuel Standard and biodiesel tax incentive have supported the growth of our industry to 3 billion gallons. Extension and optimization of policies will support the rural bioeconomy in the future.

Our industry grows and creates jobs and economic opportunities in rural communities when the biodiesel tax incentive is stable and forward-looking. For example, in 2020 the U.S. market for biodiesel and renewable diesel increased by nearly 200 million gallons even while the coronavirus pandemic reduced overall demand for transportation. We applaud Congress' proposal to provide a straightforward, multiyear extension of the biodiesel tax incentive.

NBB and its members appreciate the leadership of Rep. Cindy Axne (D–IA) and many others for advocating a long-term extension of the biodiesel tax incentive in the Build Back Better Act. This provision grew out of bipartisan legislation—H.R. 3472—that she cosponsored with Rep. Mike Kelly (R–PA) and 41 other Members of the House. The policy enjoys bicameral support with companion legislation, introduced by Senators Grassley and Cantwell and cosponsored by 12 other Senators. We ask that Congress maintain an equitable balance in duration and value for the policy in relation to other renewable energy incentives.

NBB and its members also applaud efforts to continue the Federal matching grant program supporting higher blends of biodiesel. USDA's 1 year Higher Blends Infrastructure program was a huge success, providing a tremendous return at a very low-cost. To date, ⅓ of the program's announced grants have been awarded to 24 biodiesel projects, which received a combined $23.2 million. Completion of these projects will increase consumer access to 910.7 million gallons of biodiesel while eliminating 8.5 million metric tons of greenhouse gas emissions every year at a 1 year cost of $2.83 per ton. Continuing the program will help the industry build or retrofit terminals, storage, and rail capacity to extend access to these clean, low-carbon fuels.

We thank Reps Angie Craig (D–MN) and Axne for championing a 10 year authorization and funding of this grant program and support its inclusion in the Build Back Better Act. The proposal evolved from bipartisan, bicameral legislation cosponsored by Reps. Rodney Davis (R–IL) and Dusty Johnson (R–SD) as well as Sens. Amy Klobuchar (D–MN) and Joni Ernst (R–IA). It promises to be an effective way to expand consumer access to cleaner, low-carbon transportation options.

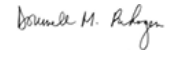
Additionally, Congress can work with the Environmental Protection Agency to optimize the Renewable Fuel Standard to achieve carbon emission reductions. It is clear that 2021 will end without EPA establishing an RFS rule for the year. It is also clear that EPA cannot meet its statutory deadline to set a 2022 rule and 2023 volumes before next year. And EPA must still consider more than 60 small refinery exemption petitions for 2019, 2020 and 2021.

EPA's delays in rulemaking create uncertainty for the biodiesel and renewable diesel industry, which hampers growth and opportunities within the rural economy. The delays allow refiners to manipulate the RFS rules and create uncertainty for renewable fuel producers. And uncertainty among biodiesel producers could undercut the value of this year's soybean harvest and impact jobs and economic growth opportunities throughout rural America.

Congress must encourage EPA and the Administration to support reasonable, sustainable growth in biodiesel volumes, issue annual rules in a timely manner, and increase the transparency of the small refinery exemption process.

Conclusion

NBB and its members thank the Committee for holding this hearing and considering this written testimony. The clean fuels industry is a pivotal contributor to rural economies across the country, creating jobs and value-added markets for agricultural partners. Moreover, biodiesel and renewable diesel use can improve environmental health and reduce associated costs for both rural and urban communities. Cleaner, better fuels highlight the contribution that rural economies can make to the nation's overall climate and carbon reduction goals. We look forward to working with Congress on policies that maximize these benefits.



DONNELL REHAGEN, *CEO,*
National Biodiesel Board.

SUBMITTED LETTER BY RINA SINGH, PH.D., EXECUTIVE VICE PRESIDENT, POLICY, ALTERNATIVE FUELS & CHEMICALS COALITION

November 16, 2021

Hon. ANTONIO DELGADO,
Chairman,
Subcommittee on Commodity Exchanges, Energy, and Credit,
House Committee on Agriculture,
Washington, D.C.;

Hon. DAVID SCOTT,
Chairman,
House Committee on Agriculture,
Washington, D.C.;

Hon. MICHELLE FISCHBACH,
Ranking Minority Member,
Subcommittee on Commodity Exchanges, Energy, and Credit,
House Committee on Agriculture,
Washington, D.C.;

Hon. GLENN THOMPSON,
Ranking Minority Member,
House Committee on Agriculture,
Washington, D.C.

Dear Chairman Delgado, Chairman Scott , Ranking Member Thompson, Ranking Member [Fischbach], and Members of the Subcommittee:

Alternative Fuels and Chemicals Coalition (AFCC) appreciates the opportunity to submit statement for the record to the United States House Subcommittee and House Agriculture Committee on the hearing, "A Look at the Renewable Economy in Rural America" being held on November 16, 2021.

AFCC and its member companies applaud the House Subcommittee on Commodity Exchange, Energy and Credit in addressing both short term and long term goals [from] which rural America would flourish, and prosper through new jobs.

Introduction

AFCC is a collaborative government affairs effort organized by the Kilpatrick Townsend & Stockton law firm and American Diversified Energy. AFCC was created to address policy and advocacy gaps at the Federal and state levels in renewable chemicals, bioplastics/biomaterials, cell-cultured food ingredients, single cell protein for food and feed, enzymes, alternative fuels, biobased products and sustainable aviation fuels (SAF) sectors. AFCC member companies work on feedstocks, renewable chemicals, food, feed, fiber, bioplastics and biomaterials, and biofuels impacting the biobased economy.

Modernizing USDA BioPreferred® Program

Tracking Renewable Chemicals and Biobased Products: NAICS Codes

The 2018 Farm Bill directs the Secretary of Agriculture and the Secretary of Commerce to jointly develop NAICS codes for renewable chemicals and biobased products manufacturers. Biobased product specific codes would greatly enhance the ability to track and report on the biobased products industry. While there is no single, centralized Federal reporting system for collecting data on Federal renewable chemicals and biobased product procurement, the requirement for the development of standardized NAICS codes for renewable chemicals and biobased products will provide a unique opportunity for standardizing reporting.

AFCC and its member companies strongly urge that OMB and the ECPC work with United States Department of Agriculture and Department of [Commerce] to develop the NAICS codes for renewable chemicals and biobased products as Congress directed in the 2018 Farm Bill. The NAICS codes for renewable chemicals and biobased products manufacturers are a requirement now since the specific NAICS codes would greatly enhance the ability to track and report on the renewable chemicals and biobased products industry, determine the funding requirements from Federal and state governments, track innovative activities in the sector, mitigate climate change, and capture the jobs created.

USDA Federal Biobased Procurement

The USDA Federal biobased procurement program, the BioPreferred® Program, encourages purchasing "green." While the program has been successful in certifying (labeling) products over the years, Federal agencies have not been required to buy BioPreferred® options where available. There is a lack of transparency with all stakeholders in the procurement process and sales data. Moreover, when advocates for the BioPreferred® Program try to tap into the additional discretionary funding

approved for the program in the 2018 Farm Bill, they are asked by Congress: "How well is the program doing?" Without sound sales numbers, it is very difficult for program advocates to answer this question and for Congress to continue supporting the growth of the program. If the program were operating properly, it would be very successful. The failings of this program need to be addressed immediately, and more time needs to be spent by USDA and its contractors developing the procurement side of the program, determining what these sales numbers are in reality, and operating the program as Congress intended. The appropriate steps need to be taken in the implementation of the program. There are contractors assigned by Federal agencies to facilitate the procurement of biobased products.

Develop Sustainability Parameters: Carbon Footprint

At a time of increased pressures on retailers, brands and manufacturers to reduce the carbon footprint of their products there exists the opportunity to create and implement a carbon intensity label or seal of biobased products for renewable chemicals and biobased products which are in the USDA BioPreferred® catalog. The carbon intensity score will be determined through the development of an American Standard Test Method (ASTM). A carbon intensity label would be of increased interest and importance to all consumers providing purchasing choices. Currently, the BioPreferred® Program does not have sustainability parameters, instead only has a biocontent which is focused on beginning of life and not end of life for the consumer product.

Smart Climate Practices for Rural America: Development of ASTM Seal

Regenerative Agriculture Practices

It is imperative that the USDA enables American producers to participate in climate conscious initiatives, including the promotion of healthy soils, carbon markets and alternative fuels, that are being demanded by consumers worldwide. American agriculture has the unique opportunity to model to the world best-in-class regenerative agriculture practices and value-added products backed by a traceable, verifiable data. This must be implemented by meeting producers where they are today, incentivizing the sound regenerative practices used across the United States, and providing the tools needed to realize the opportunities such as precision agriculture technologies and e-connectivity. The measure of carbon in the soil through standard practices developed in an ASTM will help farmers obtain tax incentives such as 45Q using a standardized test method for determining carbon capture in soil.

Creating an ASTM standard based on good science practices that utilizes baseline soil carbon storage, annual carbon sequestration level along with classical life cycle analysis to provide a standard for certifying a carbon intensity (CI) score across a broad diversity of product categories.

The ASTM standard would assist in developing standard used in:

- 45Q for carbon capture in soil[.]
- The *Growing Climate Solutions Act* would create a voluntary, producer-led carbon sequestration certification program at the U.S. Department of Agriculture (USDA) and provide farmers with technical resources to participate in carbon markets.
- USDA BioPreferred® Program with sustainable parameters or carbon footprint, thus providing consumers choices to purchase biobased products with a carbon intensity (CI) score.

New Grant Program: The Bioeconomy Development Opportunity (BDO) Zone Program

BDO Zone Supports Energy Infrastructure in Rural & Distressed Communities

The Bioeconomy Development Opportunity Zone Program is a certification and regional designation grant program that enables economic development agencies and communities to more effectively and credibly disclose feedstock-related risks and promote biobased development opportunities to developers and investors around the world.

The BDO Zone Program will leverage up to $50,000,000 to facilitate the awarding of regional feedstock and infrastructure risk ratings for communities in U.S. Federal Opportunity Zones to support the development, scale-up and investment in new facilities that produce renewable chemicals, sustainable aviation and ground transportation fuels, and other biobased manufacturing in low income rural and urban areas.

The BDO Zone Program will match investments from state economic development agencies with grants of up to $1,000,000; it will match investments from local economic development agencies, communities, nonprofits, and the private-sector with

grants of up to $100,000. The program will be funded by $25,000,000 from mandatory Federal funds. Support a national rollout of the Bioeconomy Development Opportunity (BDO) Zone Initiative to drive biobased jobs and infrastructure development in economically distressed communities

Background

The BDO Zone Initiative supports clean energy infrastructure development, equitable clean energy transition and social justice, by leveraging the New Market Tax Credit and Opportunity Zone tax incentives to drive new biofuel, biochemical, biogas and biomaterial production facilities in economically distressed regions.

Fifty-two million Americans live in economically distressed communities. These communities are plagued by a lack of investment capital—but many of them have substantial biomass assets in the form of corn stover, wood fiber, and food and farm waste. These are essential supply chain components for plants that produce ground and aviation biofuel, renewable chemicals and bioproducts. The problem is that these communities do not have the budget, the platform, or the credibility to communicate this to biobased investors and developers around the world.

The BDO Zone Initiative solves the problem by enabling communities to powerfully leverage biomass assets to serve as anchors for clean energy-based economic development.

The BDO Zone Initiative awards "AA" or "A" ratings to areas that have undergone rigorous and extensive due diligence studies, using an analysis framework comprised of more than 100 standardized, transparent and validated risk indicators. BDO Zone Ratings enable developers and investors to identify areas that qualify for powerful tax incentives and that present the low feedstock risk characteristics essential for financing biobased development. In short, BDO Zone Ratings identify the regions best positioned to locate new plants that produce biogas, biofuels, renewable chemicals, and biomaterials.

BDO Zone designations are force-multipliers for Federal, state and local incentive programs like the New Market Tax Credit and Opportunity Zone tax incentive, and other incentives designed to support renewable energy investment in economically distressed areas. Where BDO Zones overlap with these tax incentives, they supercharge the ability of these programs to unlock billions of dollars into biobased economic development and to create renewable energy jobs in economically challenged areas across the country.

Thank you for the opportunity to provide statement for the record.

Sincerely,

RINA SINGH, PH.D.,
Executive Vice President, Policy,
Alternative Fuels & Chemicals Coalition.

SUBMITTED QUESTIONS

Question Submitted by Hon. J. Luis Correa, a Representative in Congress from California

Response from Nan C. Stolzenburg, Principal Planner and Founder, Community Planning & Environmental Associates

Question. Renewable natural gas (RNG) is naturally occurring biomethane captured above the Earth's surface from sources such as dairies, poultry operations, and hog farms. When it is cleaned up, it is put into our existing natural gas infrastructure and can be used as a carbon neutral or carbon negative transportation fuel.

In 2020, California fleets fueled with California-produced RNG were carbon-negative, based on an annual average carbon intensity score of -5.845 gCO_2e/MJ, the lowest of any motor fuel in use including renewable electricity. New York State, another dairy state, is also leading in RNG production and use of clean-burning RNG in heavy duty vehicles.

Ms. Stolzenburg, what incentives do you think are needed in order to continue investments in rural America, so that we can capture this waste liability and turn it into a clean transportation fuel?

Answer. February 7, 2022

Thank you for reaching out to me requesting additional information regarding the excellent question posed by Representative Correa. I am pleased to be able to provide additional information for consideration.

Indeed, capturing biogas from farms is an important renewable energy source that benefits the environment, contributes to farm sustainability and profitability, provides new fuel sources, and that benefits our rural communities. In this memo, I have addressed several types of incentives that I feel are important. One group of incentives is oriented to communities to enhance planning for and acceptance of renewable energy facilities, and the other is oriented towards enhancing both profitability and support for participating in biogas technologies.

On the farm side, financial viability is paramount in order for this to be successful. Adequate incentives need to be in place to enable agricultural producers to reduce greenhouse gas emissions, to reward quality environmental performance, and ultimately, to produce renewable energy. At the same time, it is important to also view provision of education and ongoing support as a needed incentive to help farmers learn about and implement these technologies. Another area out of my expertise for you to consider are incentives to utilities.

Some of the incentives could include:

1. Expand the California program (Cap-and-Trade Program) to become a national program.

   In 2006, California passed the Global Warming Solutions Act, which called for the state to reduce its greenhouse gas (GHG) emissions to 1990 levels by 2020. A key component of this act is the Cap-and-Trade program, which created one of the largest carbon markets in the world. This was accomplished by setting a declining permissible level of GHG emissions (the "cap") for entities in California and requiring emitters to stay below the cap by either reducing their emissions, or by purchasing and redeeming carbon offset credits, which represent a real reduction of 1 metric ton of carbon dioxide equivalent emissions. Carbon offset credits are valuable fungible commodities that can be generated by registered compliance offset projects, which are awarded credits based on GHG emission reductions that are monitored and verified. A key component of the compliance offset program is the livestock protocol, which allows livestock operations such as dairy, cattle and swine farms to generate carbon offset credits by installing manure biogas control systems to reduce methane emissions from their facilities. After undergoing monitoring and verification, the livestock operators are awarded carbon offset credits and can sell these credits to covered entities in the Cap-and-Trade program. This not only provides a valuable additional revenue stream for farmers, but also allows them to transition their farms toward net-zero operations by significantly reducing the emission of methane, which is a powerful greenhouse gas that is twenty-five times stronger than carbon dioxide.

2. Expand the California Low Carbon Fuel Standard (LCFS) program to become a national program.

   In 2011 the California Air Resource Board (CARB) began implementation of the LCFS regulation, which was designed to incentivize the use of low-carbon fuels in the transportation sector of California, and to incentivize the production of such fuels. A key component of the LCFS program is the production of renewable natural gas (RNG) through livestock anaerobic digestion projects, which allows farmers to produce RNG from biogas generated from the digestion of manure at their facilities. The farmer is awarded LCFS credits (which are fungible commodities similar to carbon offset credits from the Cap-and-Trade program) when the fuel is used in the transportation sector in California. The number of credits awarded is based on the carbon intensity (CI) of the fuel that is generated. The lower the carbon intensity of the fuel, the more credits can be awarded. Other states are already beginning to adopt a legislation similar to the Low Carbon Fuel Standard, to incentivize the decarbonization of the transportation sector, which is one of the biggest contributors to climate change.

   Both the Cap-and-Trade program and the Low Carbon Fuel Standard have paved the way to further incentivize the implementation of anaerobic digesters at livestock farms, by awarding farmers with valuable commodities that add a significant additional revenue stream for farmers, as well as providing a structured and scientifically defensible protocol for drastically reducing methane emissions from the agricultural sector. Other states should use these two programs as a template for creating their own legislation that incentivizes anaerobic digestion projects at livestock farms, to create important sources of revenue for local farmers, bolster rural economies, and signifi-

cantly reduce methane emissions from the agricultural sector, which has been identified as a major contributor to climate change.

3. Expand USDA C-Change grants, other grants, and loan programs. Tax incentives, tax credits to offset up-front costs associated with building biodigester systems, cost sharing, cost reimbursement, loan guarantees, and other funding sources must be in place, but also must be easy for the farmer to access, and easy to administer in order for them to take advantage of. Adequate incentives in these forms should be readily available to both farmers and utilities. Financial incentives should facilitate private financing, carbon pricing, and clean fuel standards.

   California created the Dairy Digester Research and Development Program (DDRDP) which awards competitive grants to implement dairy projects that result in methane emission reductions and minimize or mitigate adverse environmental impacts. As per EPA's AgStar, this program has been "instrumental in transforming the agricultural-based AD industry. Most of these projects are focused on the generation of RNG to be utilized in California and are sourced from clusters of multiple farms." This is an example of an incentive program that should be expanded beyond California.

4. Increase awareness of and support to expand outreach to farmers through such programs as the EPA AgStar program and other educational efforts. There must be educational opportunities and advocacy in place so that the farm community learns about and understands the financial, technical, agricultural, and community implications. Many farmers are unaware of any of these programs, their benefits, or how to get involved. Once involved, they need a variety of technical support to implement and manage the program. To expand the reach to all farms who are already eligible for digester technology (such as those with more than 500 cows, or 2,000 swine), there needs to be a concerted effort to 'get the word' out to fully support these efforts. In addition to the AgStar program, an additional incentive would be to ensure that farmers have full support throughout the process. Enabling such additional support through agencies such as Cooperative Extension and our land-grant universities would be most helpful. This is an area that Cooperative Extension can be extremely helpful to work hand-in-hand with farmers on the local level.

5. Many rural communities react negatively to renewable energy facilities and activities and local plans and land use regulations often place barriers to this and other types of renewable energy facilities. Examples of 'NIMBY' related to renewables (especially solar) are extremely prevalent. While currently there are many challenges solar and wind facilities face, it is also relevant to the discussion of biomethane production and transportation when local residents become concerned about pipelines, truck traffic, noise, smells, fear of pollution, and industrial development in their community. This is a community planning issue and one that we cannot ignore.

   In order to integrate renewable energy into local landscapes and economies at a scale and design that also meets the many other needs and goals a community might have, there is a large need for adequate community planning. Many rural communities, especially, feel that the burden of hosting such facilities and negative consequences that may result from that fall disproportionately on them to serve urban areas. Communities need to be able to understand, evaluate, and find mechanisms to include and balance a variety of land uses. This is usually accomplished through long-term comprehensive or strategic planning, followed by updating local regulations. Many communities have neither the funds nor the expertise to develop these plans. Incentives to promote these activities include providing technical support and planning grants to local governments to improve their planning and zoning. These grants should require evaluation of and planning for expanded renewable energy facilities, as well as smart growth, transportation- and transit-oriented development, and farmland protection measures. Few states and even fewer local municipalities have actually gone through a concerted planning process to identify locations that would be acceptable and suitable for renewable facilities.

   Good planning would involve identifying both natural resources and critical local features that need to be protected and identifying locations that have the right conditions for the renewable facility, such as proximity to transmission lines. Through use of Geographic Information System technology, these criteria for siting solar and other renewables can be easily applied and mapped. Communities could collectively make choices about where they can

accept such facilities. Local policies can be fashioned to facilitate this. Such planning would give both renewable energy developers and local communities guidance as to where to focus efforts and this will lead to more efficient and better approval outcomes. It would eliminate the perspective that renewable facilities are being 'foisted' on them but that benefit others.

I also reiterate information from my oral testimony that offers additional details on several community-level incentives that I recommended:

- Provide assistance in the form of technology and staff to help communities navigate myriad sources of information. Fund agencies such as Cooperative Extension or others to serve as information clearinghouses to aid rural communities.
- Establish policies that incentivize use of disturbed sites first, as well as rooftop, parking lot, and building-integrated solar facilities in all locations—rural and urban—first instead of green locations. Do not put rural areas in the position of having to supply all renewable energy to urban and suburban areas.
- Provide funding to support farmland protection. Without farms, we will not be able to have farm-related biodigesters.

Thank you for the opportunity to provide these answers for the record.

Response from Randy Aberle, Executive Vice President of Agribusiness and Capital Markets, AgCountry Farm Credit Services

Question. Renewable natural gas (RNG) is a renewable fuel source driving huge clean energy investments in rural America. Turning agricultural waste into renewable natural gas (RNG) is a win-win for farms: it generates an additional source of income and also mitigates the methane emissions from livestock manure. The process of building digesters and processing biogas, however, can be a daunting endeavor.

Companies like Clean Energy Fuels, based in California, invest millions in dairy farms throughout the state, providing needed capital investments and guidance for farms as they install anaerobic digesters for capturing RNG for use in transportation.

Mr. Aberle, how do you think the Federal Government can continue to incentivize private investment in this digester technology in the rural communities where your organization operates?

Answer. January 28, 2022

To the Honorable Rep. Correa,

AgCountry Farm Credit Services and the Farm Credit System support private investment in digester technology to capture renewable biogas by financing eligible borrowers investing in this technology. Please see the linked published articles below:

https://farmcredit.com/story/dairy-goes-green-california
http://biomassmagazine.com/articles/17805/amp-americas-brings-minnesota-rng-project-online

AgCountry and the Farm Credit System understand the value of this renewable energy source that reduces methane gas emissions from livestock manure. Consumers and businesses can utilize this renewable source of energy to heat their homes and run their businesses. Many of these private digester technology providers do not meet the eligibility and scope for Farm Credit System financing, which is subject to constraints around ownership structure and requirements for owners to have some feedstock throughput to the project.

From a Lender's perspective, the Federal Government could encourage more private investment in this industry by:

1. Broadening and modernizing the eligibility authorities and scope of financing so AgCountry and the Farm Credit System could provide financing to credit worthy rural entrepreneurs to make these technology investments in rural America.
2. Providing direct grants and/or tax credits directly to both the digester technology providers and the agricultural producers providing the manure. This would encourage more investment in this technology and more ag producers willing to consider digester projects.
3. Providing 100% loan guarantees for lenders to finance the construction and installation of the digester projects. Most of these installations are large projects and do not fit the Guaranteed Loans and Grants under the Rural Energy for America Programs for Renewable Energy Systems (REAP). Increased

government loan guarantee levels would allow entrepreneurs' private investment dollars to be leveraged with lender funds with limited lender risk.

The Federal Government should continue to support and incentivize private investment in renewable energy in rural communities through USDA and other bioenergy programs. These Federal incentives supplement the private investment to accelerate the renewable energy infrastructure build-out for the benefit of agriculture, rural America and the environment. The government support of these projects provides a better foundation towards a successful bioenergy project.

Please reach out directly with any additional questions. Thank you for the opportunity to respond.

Sincerely,

RANDY ABERLE,
EVP Agribusiness and Capital Markets.

ATTACHMENT 1

FARM CREDIT

[*https://farmcredit.com/story/dairy-goes-green-california]*

Dairy Goes Green in California

Southern San Joaquin Valley, California

Farm Credit West[1] *supports the dairy industry, the environment and local communities by financing a methane converter project in California.*

In less than a decade, California's dairy industry—the nation's leader in milk production and the state's largest agricultural commodity-faces a daunting requirement: reduce greenhouse gas emissions from manure storage by 40 percent. Considering the industry's 1.7 million dairy cows are the state's largest agricultural methane producer, it's an imposing task to accomplish by 2030—but given the economic stakes, a crucial one.

Farm Credit: financing the future

Deeply committed to its customers, Farm Credit West has taken bold action and become the principle financier of a solution to this challenge. It's a solution that simultaneously helps dairy producers reduce their emissions and meet the state mandate, while also providing cleaner air and economic vitality to some of California's most under-served areas.

Farm Credit West has partnered with California Bioenergy (CalBio), a dairy digester developer, Chevron U.S.A. and California dairy farmers to build three clusters of methane digesters and upgraders across California's southern Central Valley.

[1] *https://www.farmcreditwest.com/*.

The digesters and upgraders, built by CalBio, repurpose methane released from dairy manure by first capturing, then converting it to renewable natural gas (RNG). The methane captured in digesters at the dairy farms is sent to a centralized processing facility where it is upgraded to RNG and injected into local utility SoCalGas and PG&E's pipelines. The RNG is then marketed as an alternative fuel for heavy-duty trucks and buses, many of which regularly travel the Central Valley corridor.

A win-win-win

Farm Credit West's plan moving forward comprises 17 digester sites in three different clusters across Kern, Tulare and Kings counties. Dairy owners provide the manure and the site on which to build the digester. The farmers then receive a percentage of the profits from the sale of RNG, as well as renewable energy credits from California's cap-and-trade energy market and the National Renewable Fuel Standards program.

In addition to providing an elegant solution to the dairy industry's looming emissions-reduction mandate, this project attracts numerous construction and engineering jobs to the state's Central Valley, an area that struggles with high rates of poverty and joblessness.

Farm Credit West Senior Vice President Jonathan Kennedy has been working on the project for more than a year. He describes it a win-win-win for California.

"This project is good for all the stakeholders involved," Jonathan said. "Cleaner air benefits not just agriculture, but the whole community. In terms of the dairy industry, it provides additional viable income. And the communities where these will be built-some are the most impoverished in the state—will benefit from well paid, stable jobs."

Farm Credit stepped up to the challenge

Jonathan, who has worked for Farm Credit West for 31 years, says the deal was the most complex he'd ever worked on. Since they had never financed a digester project this large, the underwriting process involved numerous meetings with attorneys and real estate professionals; drawing up land leases and pipeline easements; drafting agreements between dairy farmers and CalBio; and determining the value of fuel and how it will be paid for, among other steps.

In the end, Farm Credit West's history of supporting local producers and experience with the dairy sector made the decision to finance a forward-thinking project with numerous benefits to the dairy industry, the environment and community an easy one.

"Our commitment to agriculture and to the dairy industry in all of California, and also the personal relationships we have with dairy producers, made it clear this is something we needed to be a part of," Jonathan said. "Other banks may not have looked at it from that perspective."

The project is owned by individual dairy farmers, Chevron, and California Bioenergy, LLC, whom all contributed significant equity. Farm Credit West, in conjunction with CoBank, provided $50 million in loan funding. Additional agencies provided support and capital too, including the California Air Resource Control Board, the California Department of Food and Agriculture, the California Energy Commission, the California Public Utilities Commission and the Natural Resources Conservation Service.

A perfect fit for Farm Credit's mission

Farm Credit West President and CEO Mark Littlefield echoed Jonathan's sentiments. In a video recorded for a virtual ribbon cutting in September 2020, Mark said providing the economic engine for this project fulfills Farm Credit West's mission to support agricultural producers and the communities they serve.

"The California Bioenergy project allows our customers to meet their business goals, strengthens rural economies, improves local air quality and contributes to a healthy, sustainable future," Mark said. "For more than a century, Farm Credit West has supported rural communities and agriculture with consistent, reliable credit and financial services. As a member-owned cooperative, we are intimately connected to the pressures and opportunities facing dairy producers today, and it is our mission to develop unique solutions to help these growers thrive. We've been adapting and innovating with our customer-owners for the last one hundred years; we won't stop now."

A version of this article first appeared in Farm Credit West's *Spotlight Magazine,*[2] titled, "Financing the Future," by Sarah Kearbey.

[2] *https://issuu.com/farmcreditwest/docs/fcw_spotlight_winter_2020_web.*

ATTACHMENT 2

BIOMASS
MAGAZINE

http://biomassmagazine.com/articles/17805/amp-americas-brings-minnesota-rng-project-online

Amp Americas brings Minnesota RNG project online

By Amp Americas |March 16, 2021

Amp Americas on March 10 announced that its fourth biogas facility producing renewable natural gas (RNG) from dairy waste is now operational and delivering RNG to the pipeline. The facility is located in Morris, Minnesota. **Source:** Amp Americas.

Amp Americas, a pioneer in the renewable transportation fuel industry, on March 10 announced that its fourth biogas facility producing renewable natural gas (RNG) from dairy waste is now operational and has begun delivering RNG into the Alliance natural gas pipeline to be used as transportation fuel. Located in Morris, Minnesota near the state's western border, the new plant is Amp Americas' largest dairy RNG project to date and the state's first on-farm biogas-to-vehicle fuel facility. With this project, Amp Americas has now developed dairy RNG production on 12 dairies with over 66,000 cows.

Working with Riverview LLP, a dairy operation based in Minnesota, the project captures over 700,000 gallons of manure per day from three different sites, converts it into renewable methane, purifies it into RNG, and compresses it to inject into the pipeline. Along with two RNG projects in Indiana and another in Arizona, Amp Americas is now operating four of the largest dairy biogas-to-transportation fuel projects in the country, producing a total of over 10 million gallons of RNG annually. Amp Americas markets its dairy RNG to fleets in California along with gas from a number of other dairy, landfill, and wastewater projects developed by others through its Amp Americas Marketing arm.

"We're thrilled to partner with Riverview and to launch our largest project to date," said Grant Zimmerman, CEO of Amp Americas. "We installed pipelines connecting three of Riverview's dairies, restarted mothballed digesters, and built our RNG plant and the pipeline injection station. This project will produce millions of gallons of 100% renewable transportation fuel and will prevent 100,000 tons of greenhouse emissions each year, the equivalent of taking over 20,000 cars off the road annually."

Brad Fehr, partner of Riverview LLP explained, "We were skeptical of digester projects and developers before we decided to work with Amp Americas. They built

an important project for our community, and we look forward to our long-term partnership."

During construction, the project employed 140 people, and now in operations, Amp Americas has added six permanent full-time jobs in Morris, Minnesota bringing the company's team to a total of 60 across six states. Amp Americas will operate the Riverview RNG facilities under its Amp Americas Services business, a unit of Amp Americas that leverages its 9 years of unique experience, expertise, and leadership in biogas operations. Amp Services also operates other dairy RNG projects such as the company's Indiana projects now owned by Generate Capital, and another dairy RNG project located in Arizona.

Amp Americas recently expanded its ongoing relationship with EIV Capital, LLC, to provide the required equity investment needed for continued buildout of the business. David Finan, partner of EIV Capital, LLC stated, "Amp's growing platform provides true value to the communities in which it operates and also to its employees and investors. We are grateful to work with a team that can leverage its decade-plus experience of continuous operations in the dairy RNG space to build a leading business in the development and management of these assets."

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